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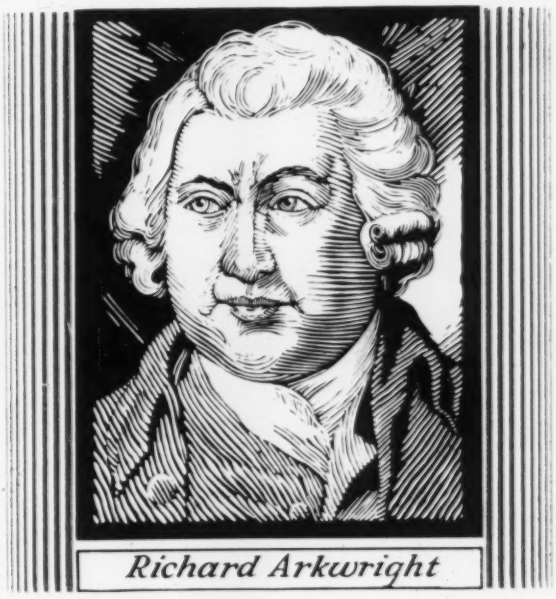
OCTOBER 1933

MACHINE DESIGN



Richard Arkwright

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We have extensive experience data on the uses of Nickel Alloy Steels, Nickel Cast Irons, Nickel Bronzes and other Nickel Alloys, and will be glad to send you full information. Our engineers have had broad experience in the solution of problems involving the use of Nickel. You may feel free to consult them at any time regarding your requirements.

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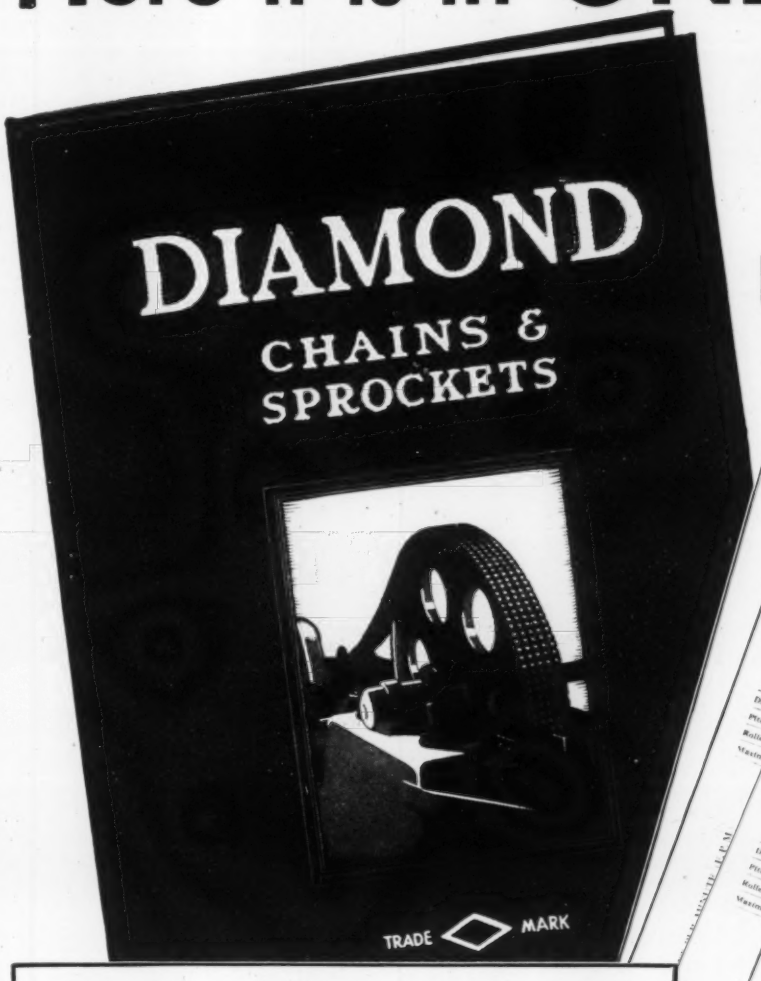

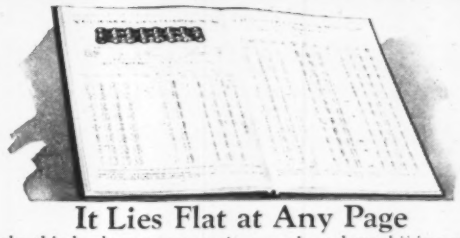

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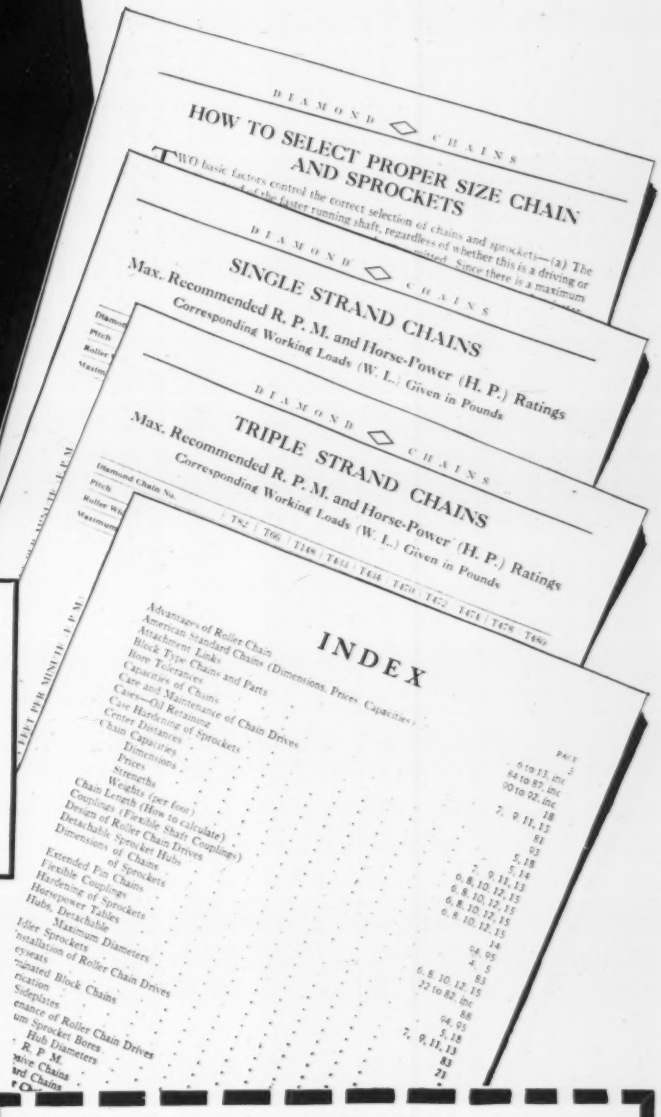
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THESE few sample pages indicate the completeness of this new Diamond Chain Drive "encyclopedia". Whether your problem is driving machines from a line-shaft—driving from individual motors—driving or coordinating units of a machine—transmitting many horsepower or a few, over short centers or long, at high speeds or low—you will find the answer here. Fill out and mail coupon now for your copy.

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CALENDAR OF MEETINGS AND EXPOSITIONS

Oct. 11-12—National Association of Farm Equipment Manufacturers. Annual meeting to be held at Congress hotel, Chicago. H. J. Sameit, 608 South Dearborn street, Chicago, is secretary of the association.

Oct. 16-21—National Business Show. Thirtieth national exposition of typewriters, calculating machines, addressing machines, recorders, card sorters and all types of business machinery to be held at Grand Central Palace, New York. Information on the exhibition may be obtained from E. Tupper, 50 Church street, New York.

Oct. 17-19—Association of Iron and Steel Electrical Engineers. Mechanical, combustion, lubrication, electrical and safety division meetings, twenty-ninth annual convention and iron and steel exposition to be held at Wm. Penn hotel, Pittsburgh. Technical papers to be presented will include: "Recent Developments in Electrical Equipment of Cold Strip Mills of Various Types," by F. Mohler; "Antifriction Bearings in Connection with Cold Mills," by F. C. Hallmark and C. J. Klein; "Mechanical, Lubrication and Electrical Problems in Connection with Reduction Gear Sets of Main Drive Mill Motors," by T. Holloway and Austin Kuhns; "Welded Rolled Steel Products," by F. L. Lindmuth; and "Advantages of Welded Design with Reference to Weight, Strength, Time and Costs," by A. E. Gibson. John F. Kelly, 1010 Empire building, Pittsburgh, is managing director of the association.

Oct. 30-Nov. 4—Automotive Service Industries Show. Annual exposition to be held at Merchandise Mart, Chicago, sponsored by Motor and Equipment Manufacturer's association, National Standard Parts association and Motor and Equipment Wholesalers' association. C. C. Secrist, 5750 Roosevelt road, Chicago, is secretary of the equipment manufacturer's association.

Nov. 2-11—Commercial Motor and Transport Vehicle Exhibition. To be held at London, England.

Dec. 4-9—Fourteenth Exposition of Chemical Industries. Exhibition of equipment and parts to be held at Grand Central Palace, New York. Information may be obtained from the Exposition management at Grand Central Palace.

Jan. 6-13—New York Automobile Show. Annual exposition of new machines and parts to be held at Grand Central Palace, New York.

Jan. 8—Society of Automotive Engineers. Annual dinner to be held in New York in conjunction with automobile show. John A. C. Warner, 29 West Thirty-ninth street, New York, is general manager of the society.

Jan. 9—Mining and Metallurgical Society of America. Annual meeting to be held at New York. Percy E. Barbour, 75 West street, New York, is secretary of the society.

Jan. 22-25—Society of Automotive Engineers. Annual meeting which will include a program of technical papers to be held in Detroit. John A. C. Warner, 29 West Thirty-ninth street, New York, is general manager of the Automotive society.

Feb. 5-9—International Heating and Ventilating Exposition. Third annual exhibition of heating, ventilating and air conditioning equipment and methods to be held at Grand Central Palace, New York. Charles F. Roth, Grand Central Palace, New York, is manager of the exposition.

March 13-16—Fourth Packaging, Packing and Shipping Exposition. Annual display of machines and advances in the technique of modern packaging, packing and shipping under the auspices of American Management association to be held at Hotel Astor, New York. John G. Goetz, 20 Vesey street, New York, is managing director of the management association.

MACHINE DESIGN

THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO

October, 1933 Vol. 5—No. 10

Simplified Calculations Unshackle the Designer

By Joseph Harrington Jr.

DESIGNERS have developed many machines which make the work of operators less laborious, yet heretofore little effort has been expended toward making the work of the designers themselves less tiresome. Mr. Harrington, United Shoe Machinery Corp., will demonstrate in a series of four articles of which this is the first, how many hours of calculating time can be saved.

FORCE analysis in dynamic mechanisms is one of the most tedious sets of calculations which face the designer. For this reason an important design step is frequently neglected. This series of articles and the charts accompanying them will present a method for the easy determination of forces encountered at any point of a dynamic system of parts actuated by a cam or similar driving member producing varying accelerations of the parts. No claim is made to originality of the mathematics here explained. Such merit as there may be lies in the elimination of drudgery in the solution, and in the outline of steps which will make this analytical method available to all.

It scarcely need be repeated here that the strength design of any part depends upon a knowledge of the forces acting upon that part *and* the forces engendered by the mass of the part. Consider the side rods of a locomotive which transmit large forces and are whipped up and down at the same time. They are subject to two loadings for they must sustain not only the force which they transmit from crosshead to wheel, but the additional force necessarily applied to whip them around so rapidly — first a tremendous acceleration, then a deceleration, and next an acceleration in the opposite direction. (Incidentally, though we shall not consider it here, internal dynamic stresses must not be overlooked when designing.)

Unfortunately the analysis of the interpart forces in a train of moving parts is not simple. It involves a knowledge of the mass, moment of inertia, center of rotation, and acceleration of every piece in the train. While not insurmountable obstacles, the calculations are extremely discouraging; and most designers prefer to guess at the necessary size and forces involved and let it go at that. It is possible to devise graphic methods which will eliminate this drudgery.

"Train" Is Defined

A "train" as used in this discussion will mean a series of connected links, levers, gears, shafts, cranks or similar parts which are consecutively connected for the purpose of producing some specified motion of the end part, the tool for in-

stance. The work reaction on the first piece is carried back through the train to the source of power. Also the inertia forces necessary to move the first piece in its path at the desired speed are carried back through the train. The piece next to the first piece, also in motion, will require a force to overcome its inertia and that force also will be carried back to the end of the train. Fig. 1 illustrates the cumulative effect of the forces.

Loads Are Indicated

The arrows in Fig. 1 indicate loads which must be carried from one part to another by pins, rolls, knife edges, springs, keys or bolts. Each piece must transmit the work force and also accelerate everything to its left. The leverage principle may scale the whole system up or down in passing through some one part, and the acceleration (which enters into the inertia forces) may change from part to part, but the principle of concatenation remains the same.

For a good design we must know within a few per cent (2½ per cent for most work) what the forces are in order to calculate the following aspects:

1. Connecting units—pins, pivots, knife edges, bearing surfaces, springs, bolts, keys, setscrews, etc. This means knowledge of interpart forces

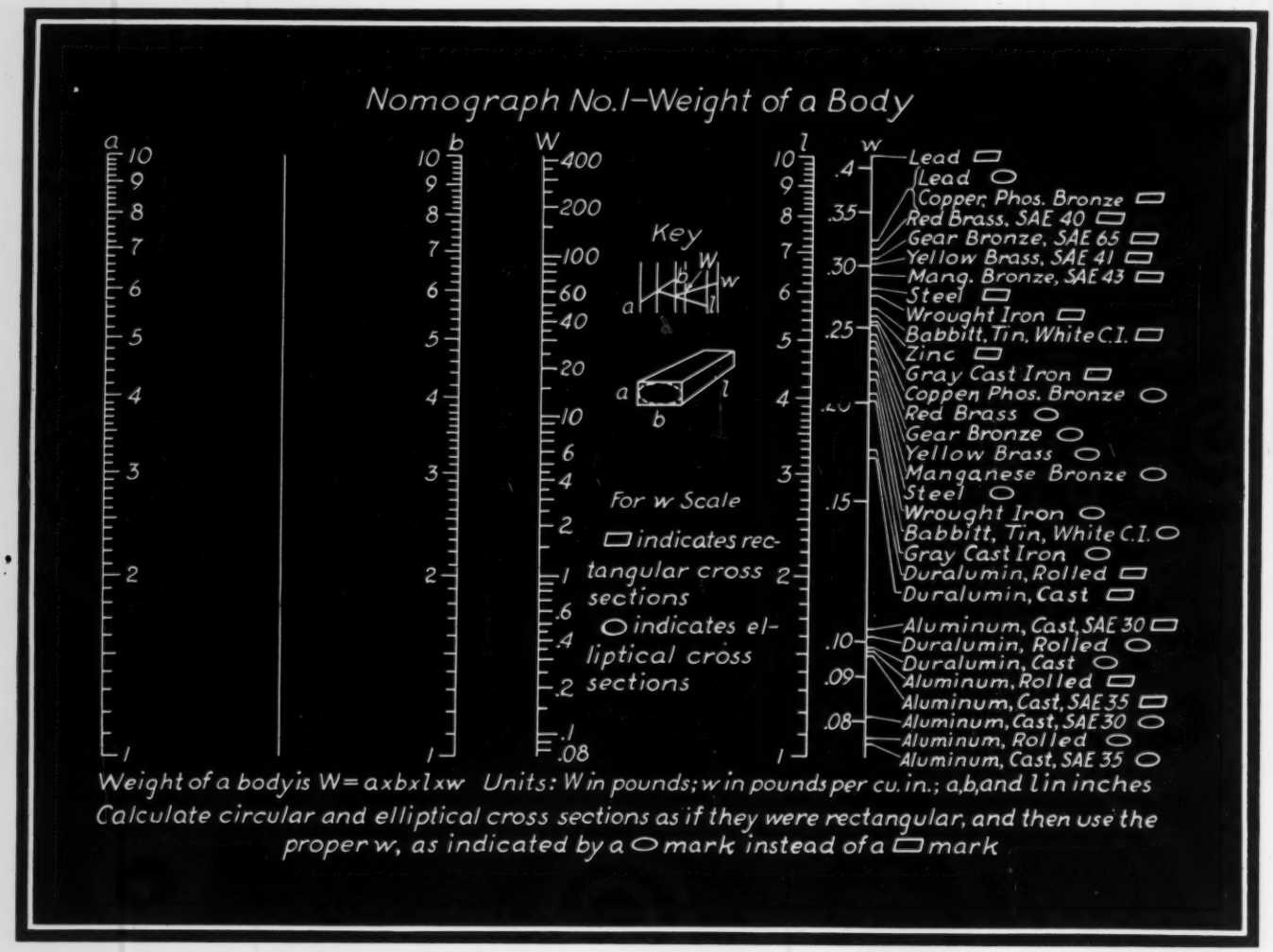
2. Supporting pieces — frames, studs, columns, beams, etc., which take the thrust of the pieces in the train. This means knowledge of the forces at either end of any part

3. Lubrication — slides, bearings, splines, etc. This means knowledge of forces listed in sections 1 and 2 and a knowledge of the relative speeds of the surfaces

4. Strength of parts. This requires knowledge of *all* forces working on a piece-work force, inertia forces, supporting forces, etc., (and the internal dynamic stresses)

5. Power input requirements. This demands a knowledge of work force required and the total force exerted by the last piece on its driver

As these aspects cover practically the entire design of any part, it is readily seen that this analysis must be made if the design is to be anything but a guess.



The problem now narrows itself to the question: How big are the inertia forces? The fundamental formula for inertia forces is our old friend

$$F = Ma$$

where F is the force, M the mass of the piece and a its acceleration. M is an inherent quality of the parts of the train and is unvarying in magnitude. F is the quality we are searching for; M the assumed known. It is not the purpose of these articles to enter into a discussion of the many methods[1] available to determine the magnitude of the acceleration, a, produced in the last piece of the train by the driving member. We shall assume that the acceleration-time curve for the last part of the train has been determined from the space-time curve of the driving mechanism and is at hand when the force analysis is begun. Fig. 2 shows such an acceleration curve.

Determine Velocities First

If one end of a train of parts is accelerated all the other connected members will receive some acceleration, either positive, negative or zero, depending on the design of the train. It is necessary to determine the accelerations of

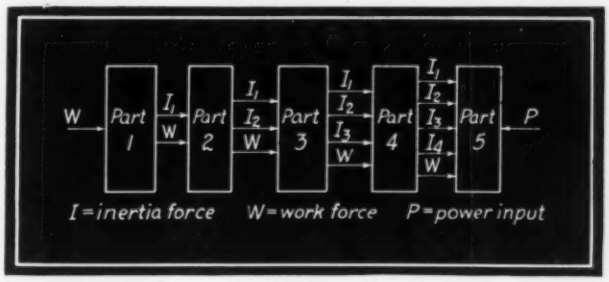


Fig. 1—Cumulative load must be carried from one part to another successively

each part before calculating the inertia forces. Therefore, it is best to proceed along this line of attack: The velocity of each connecting point[2] relative to the frame of the machine must be determined. From the velocity we can find the radial accelerations of all the connecting points which rotate about a fixed pivot (this generally includes all the connecting points). Knowing the accelerations imparted to the driver end of the last piece in the train, the cam follower for instance, we can proceed through the train finding the acceleration of each connecting point with reference to the frame. Then for pieces which rotate about a fixed pivot we determine the angular acceleration, and for pieces which are not rotating about a fixed pivot, connecting rods, etc., we determine the acceleration of the center of gravity. With this data we can proceed to determine forces acting, which was our original aim.

A complete analysis of the problem of deter-

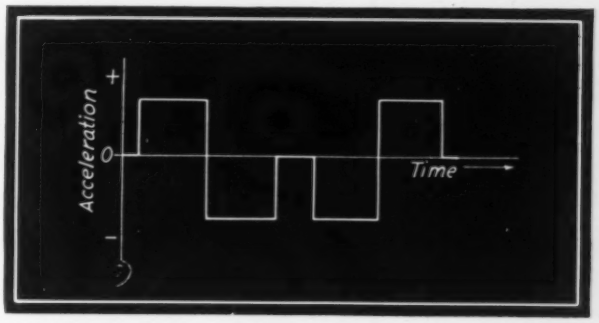


Fig. 2—Acceleration curves should be determined before the force analysis is begun

mining these forces for parts which rotate about a fixed point and for those parts which do not rotate about such a point but are flying parts will be included in the November and December issues of MACHINE DESIGN. The use of nomographs, for elimination of all calculations except the simple one of addition, which will accompany these articles, will be explained in the January issue.

Designers Consider User's Problems

DESIGN in its fullest state of development is revealed by a recent advertisement which says in part "These men in our large engineering department continually design new machines—devise new methods for handling your milling and grinding operations. They constantly endeavor to achieve the highest standards of performance and maintain definite standards of design. Your problems are theirs. Your ideas—your requirements are constantly in front of them. They know our product and what it can do for you. They are 'customer minded.'"

A COURSE in steel mill roll pass design, said to be the first of its kind, will be offered by Carnegie Institute of Technology this year in its night school. Only men in the roll business are eligible to matriculate. Prof. W. Trinks, author of two books on roll pass design, will teach the class.

[1] The fundamental methods are:
Graphical differentiation of a space-time plot.
Tabular differentiation.
Calcular differentiation.
Use of vector diagrams and acceleration images.

[2] A connecting point is the point at which force is transferred from one part to another—as the center line of the pin in a pinned joint.

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

Watch Independent Springing!

WITH the trend in automotive design pointing distinctly toward wider acceptance of independent wheel suspension (M. D. Sept. p. 39), engineers can profitably observe what European engineers have developed along this line. A comprehensive discussion on the subject by the French engineer Georges Broulhiet at the International Automotive Engineering congress in Chicago recently, brought out details of a parallelogram type, Fig. 1. This design was conceived for front wheels. The king pin of the steering knuckle is carried by a part 3 attached to the chassis at the upper end by a short lever 6 and at the lower end by two levers 7 and 9.

Suspension is through a transverse spring, the ends of which are joined with the lower lever 7 by a simple coupling; this spring embodies an arithmetic spacing of the leaves with rollers that suppress friction, at the ends of the different leaves. Tie rod of the steering knuckles is broken at the center; the two halves are attached to third joint receiving the steering drag link. Axis a central lever carrying three ball joints, the of the central lever is joined to the chassis; steering therefore, is suspended and is not at all influenced by displacement of the wheels. The parallelogram type takes advantage of the large sizes of all parts, thus allowing high resistance design with low weight.

This field promises unlimited opportunities for new ideas in independent springing, particularly since auto builders are finding this system the key to easier riding. The Dubonnet unit was described on page 16 of the April issue.

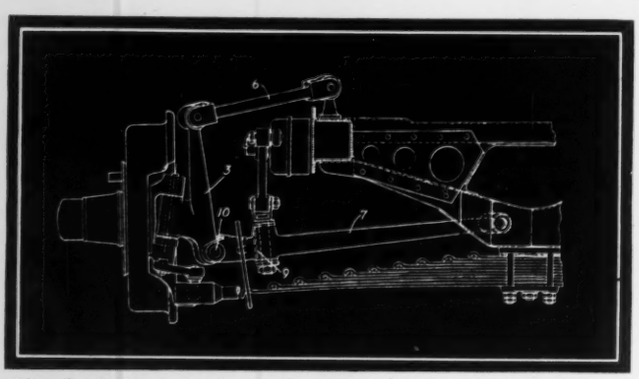


Fig. 1—Independent wheel suspension is through a transverse spring in the Broulhiet parallelogram system

Embodying Safety in Pressure Rolls

FOUR rolls instead of the conventional two have been embodied in a new domestic clothes wringer which provides a factor of safety that marks a unique idea in design. The arrangement, as indicated in Fig. 2, is extremely simple. C. B. Williams, Williams Industries Inc., Cleveland, conceived it and owns the patents.

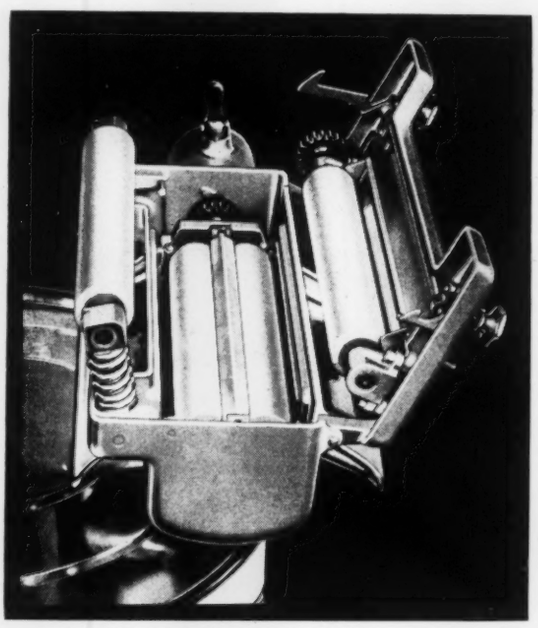


Fig. 2—By the addition of two safety rolls this wringer prevents accidents to operators

The two rolls shown in the lower assembly in the illustration serve as the safety rolls. These are supported by coil springs which provide about 15 pounds pressure. Heavier springs are

used for the pressure roll shown at left to afford a wringing pressure of 500 pounds against a companion top roll mounted in the cover of the unit. This latter roll acts as the driving medium through a gear which when the cover is closed meshes with a gear on a stub drive shaft that runs continuously.

Clothes can be fed from either side without the necessity for a reversing unit. The light pressure between the lower and upper rolls is sufficient to carry the wet piece of cloth into the wringing mechanism. As it meets the angular deflector bar that bridges the lower roll assembly the work is deflected upward and passes between the two top rolls that wring the clothes.

If the hand of the operator should be drawn accidentally into the wringer it would not be injured as the pressure between the first two rolls is only 15 pounds, permitting easy withdrawal. In case of entanglement with clothes any chance of the hand being drawn along to the extreme pressure top rolls is forestalled by a device which trips the release. This throws back the cover, disengages the gears and stops the mechanism. The trip is actuated by vertical levers on the lower roll assembly that push the cover clamps off their retaining pins when the lower rolls are depressed over ¾-inch. The same releasing device comes into play when the wringer is jammed or overloaded.

Barrels Welded by Automatic Unit

TYPICAL of the various machines that have been designed for processing equipment to meet present-day requirements of the brewery industry is an automatic welding unit for metal barrels. The shielded arc process is employed. Single or double automatic welding heads are supplied as shown in Fig. 3. Lincoln Electric Co., Cleveland, developed the unit.

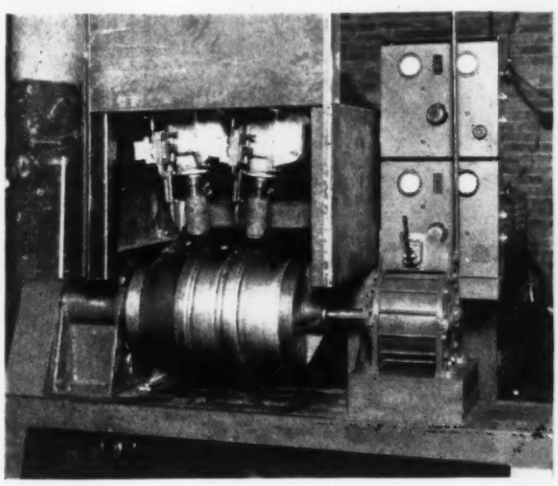


Fig. 3—Beer barrel revolves under stationary heads as arc welding progresses in automatic machine

When two circumferential welds in the same shell are required both are made simultaneously. Welding heads are so designed that although operating within a few inches of each other, neither arc disturbs nor affects the operation of the other. The heads remain stationary, the barrels being revolved automatically under the arc as the welding progresses.

This idea holds possibilities in other industries where cylindrical objects are fabricated.

Cork Insert Stops Shaft End-Play

OBJECTIONAL motor shaft end-play noise is obviated by the use of cork in the application featured by the Delco Products Corp., Dayton, O., on its motors. As shown in Fig. 4, any longitudinal movement of the motor is cushioned by the cork bumper which presses against the shaft. A steel retainer is employed to hold the cork securely in position. As indicated by this example nonmetallic materials afford the designer numerous opportunities to combat noise and vibration.

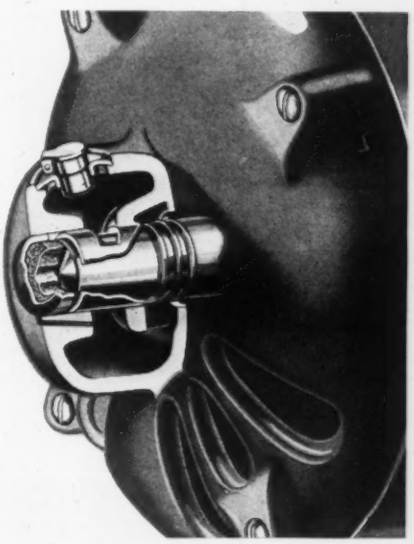


Fig. 4—Cork insert obviates noise by preventing end-play in motor shaft

Pump Handles Solidifying Mixture

HANDLING of asphalt, tar products, oils, etc. in road building equipment is one of the problems that confronts designers in this field. A typical solution is found in one of the more modern units, the bituminous pressure distributor developed recently by Municipal Supply Co., South Bend, Ind. Reference is made to the design features of the Viking pump, Fig. 5, which

plays an important part in spraying the contents of the tank on the road.

The casing of the pump is designed to allow the liquid to be taken in at the side and discharged through the bottom, permitting the unit to drain completely when not in use. Only two

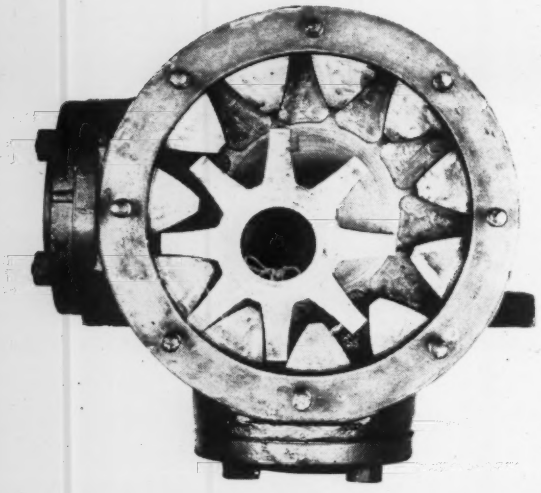


Fig. 5—Pump employs geared rotor to deliver road oil under pressure in bituminous distributor

moving parts are employed, a rotor and idler which when meshed form a barrier between the intake and discharge ports. The idler in drawing away creates suction, and the opening therefore is filled with liquid. As the eccentrically mounted idler progresses and the other teeth mesh the liquid which has filled the spaces is forced out through the discharge port.

Capacity of the pump is 250 gallons per minute. Five different speeds are available, the revolutions per minute being designated by a tachometer operated from the pump shaft. The pump, all piping and control cocks are enclosed in a metal heater jacket, with provision made for applying heat with a portable burner.

Timing Watches Stroboscopically

BY STROBOSCOPIC means watches now may be regulated in ten minutes instead of ten days, the time generally required. An image of the balance wheel is reflected on a mirror, permitting a comparison of its speed with the speed of flashes of a light from a flashing lamp. By a simple adjustment of the timer the actual loss or gain in seconds made by the watch may be observed from the dial of the timer. Comparison of the speeds of the wheel and lamp is made possible by use of the stroboscopic principle.

The lamp illuminates the spokes of the wheel only during the flashes, and the speed of the flashing is such that during the intervals between flashes the wheel turns just enough so that its second spoke occupies the position the first spoke held at the time of the previous flash. Thus the wheel appears to stand still. If the watch is not keeping correct time the wheel seems to move slowly in one direction or the other. The amount by which the watch is in error is found by adjusting the rate of the flashing lamp until the wheel appears to be stationary. Bell Telephone Laboratories and Electrical Research Products Inc. developed the timer.

Eccentric Permits Rapid Adjustment

OPERATORS often are prone to neglect adjustments that require time and are tedious to make. For that reason the designer should simplify as much as possible the means for adjusting his machine to meet varying conditions. An example of this is the scrap cutter, Fig. 6, on the new rotary side trimming and slitting shear developed by Streine Tool & Mfg. Co., New Bremen, O. The original design called for shims to be placed under the blades when the cutter failed to sever the strip of scrap coming from the sheet being slit. This sometimes occurred when light gage stock was processed after the machine had been handling heavier material.

Because the operator found it more or less irksome to remove each blade from the cutter

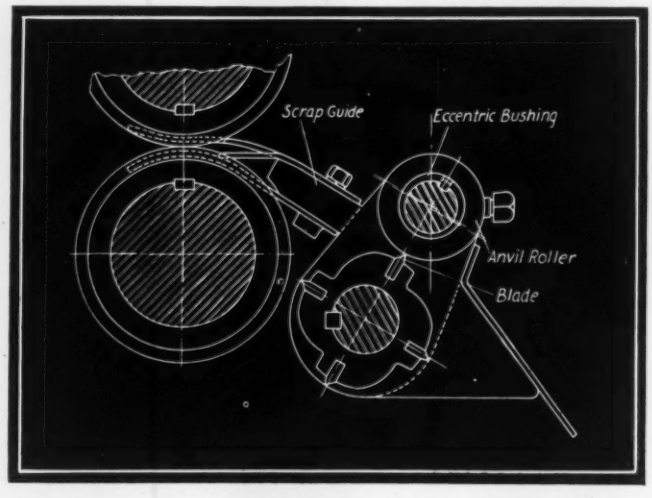


Fig. 6—Eccentric bushing facilitates adjustment of anvil roller to blades in cutting scrap metal

and install the shims, this task sometimes was neglected. The designers early recognized that this condition constituted a handicap of their machine and developed the arrangement shown in Fig. 6. Eccentric tool steel bushings are inserted between the shaft and the anvil roller, these bushings being keyed as depicted. When a crank

handle on the shaft extension at the side of the machine is actuated by the operator the surface of the anvil roller is presented nearer or closer to the cutting edges of the blades. By moving the handle progressively through a semicircular series of stops a change of 1/1000-inch for each step is effected in the distance between the anvil roller and the blades. With the new design, adjustment can be made while the machine is in operation and material is being processed.

Simplicity Aids Interchangeability

SIMPLICITY, to which all alert designers aspire, characterizes the feather valves, Fig. 7, employed on the new refrigerator compressors

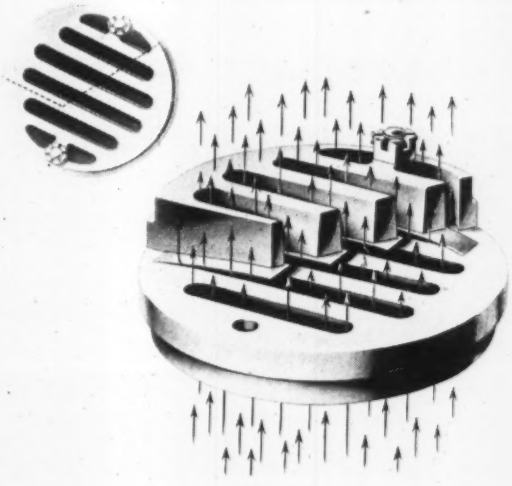


Fig. 7—Strips of ribbon steel are lifted to permit passage of air in operation of valve

built by Worthington Pump & Machinery Corp., Harrison, N. J. Strips of ribbon steel seat tightly on the ground face-slotted seats. In opening, the valve is permitted to lift in the middle against a curved guard to allow the passage of air on either side of the strip. The valve is not held rigidly at any point, being restrained from lateral movement only by recesses in the curved guard. Complete freedom of the strip is assured by steel inserts placed vertically across the end of the opening, forming a stop for the valve strip and preventing possibility of pinching. Intake and discharge valves are identical and interchangeable.

Aircooled Engine Gains Favor

ANOTHER aircooled engine has been introduced, supporting the contention of many engineers that the trend is in this direction. Designed especially to meet the demand for an aircooled unit in the compressor, truck, tractor and general industrial fields, Doman & Marks, Syracuse, N. Y., builders of the unit, Fig. 8, have utilized a large centrifugal blower mounted on the crankshaft. Cooling air is divided into two distinct streams, one going to the cylinder heads and one to the cylinder barrels, thus eliminating eddy currents in the ducts.

The cold air stream flows along the exhaust side of the engine which brings cooling air in contact with the warmest parts of the cylinder heads first. Cooling fins are carried on the cylinders down to the crankcase, thus assuring low cylinder wall temperatures. Uniform temperatures around the periphery of the cylinders are made certain by the shorter cooling fins on the blast side. The dangers of contamination from water condensation are eliminated by cooling of the crankcase, air from the cylinders passing through a specially constructed funnel arrangement which creates a suction in the crankcase and draws cool clean air through.

Aluminum Solves Weight Problem

ALUMINUM promises new hope for the elevated railroads which the metropolitan public has been deserting for the stuffy but speedy subways. A light weight high speed type of elevated car is being developed which will operate safely over the present system of overhead structures. The car conforms to the original axle loading of 25,000 pounds, set up for the elevated system. Prior to the selection of aluminum the elevateds have been unable to increase their speed or to put on better equipment because present structures would not carry the additional load. The new car was developed co-operatively by two transportation companies.

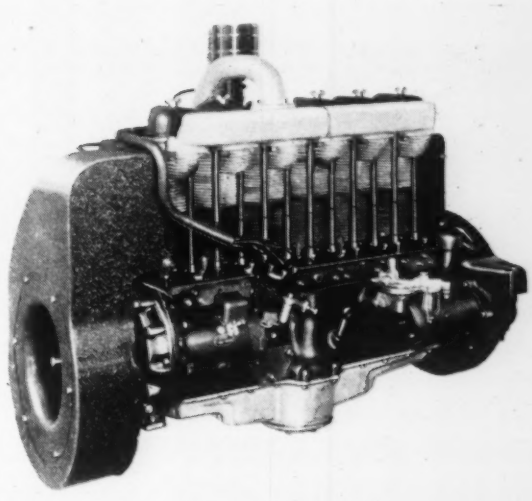


Fig. 8—Centrifugal blower on crankshaft furnishes air in two streams for cooling this engine

Utilizing Full Efficiency of

By James A. Hall

and

Harold S. Sizer

CIRCUMSTANCES alter cases — a well known axiom yet one often overlooked. In this article the authors illustrate how special gear teeth may be evolved to satisfy particular applications more fully than would standard gears. Mr. Hall is professor of mechanical engineering, Brown University and a Brown and Sharpe consulting engineer, while Mr. Sizer is an engineer of Brown and Sharpe Mfg. Co., Providence, R. I.

GEARS with nonstandard involute teeth usually are avoided by designers. This may be due to the emphasis which has been placed on standardization, but with most gears having their entire useful life in the machine for which they were made, the primary value of standardization is in the use of standard production methods. Standard hobs or shaping cutters can be used to produce teeth with long or short addendums just as readily as teeth of standard proportions.

The principal reason for using nonstandard addendums is to avoid interference or undercutting which is characteristic of involute pinions with small numbers of teeth. Fig. 2*A* shows a standard 12-tooth 14½-degree pressure angle involute pinion cut by a hob with straight-sided teeth. The badly undercut pinion teeth are structurally weak and the involute curve is destroyed in the region of the base circle. The number of teeth in contact, even when running with a large gear or rack, will be less than unity, thus precluding perfect action.

Difficulties Are Encountered

Various schemes are in use or have been proposed to eliminate this difficulty and still maintain standard tooth proportions, but most of these involve departing from the true involute. This raises difficulties where the teeth are generated, as the basic rack of a true involute system has straight sides while a modification usually requires some curves. Hobs for the true involute system therefore will be more easily produced. Furthermore, the problem of gear grinding is simpler than the involute curve. The abrasive wheel of a gear grinding machine is, as a rule, given the rack tooth form on one or both sides of its outer rim and this shape is maintained more readily in truing with a diamond if the sides are straight.

With these various reasons for using true involutes, it is the purpose of this article to show how a standard hob or similar generating cutter used on a standard machine may be used to cut gears of true involute shape which will avoid the disadvantages of the standard involute system on small pinions.

A typical, nonstandard involute pinion cut with a standard, IP-14½-degree hob is shown in Fig. 2*B*. This special 12T pinion is of the long addendum, short dedendum type and has been cut from a 13T blank, a blank 15 inches in outside diameter instead of the usual 14 inches. During generation the rotation of the hob and blank were exactly the same as though a standard 12T pinion were being cut. The only element in the entire set-up which was not standard was that of center distance. Due to the increase in the outside radius of the blank the hob was mounted ½ inch farther from the gear axis than would be required for a normal gear.

Five of the desirable characteristics of the long addendum-short dedendum pinion are:

Undercut has been reduced and the thickness of tooth at the base circle has been increased. The pinion teeth are thus far stronger than those of Fig. 2*A*

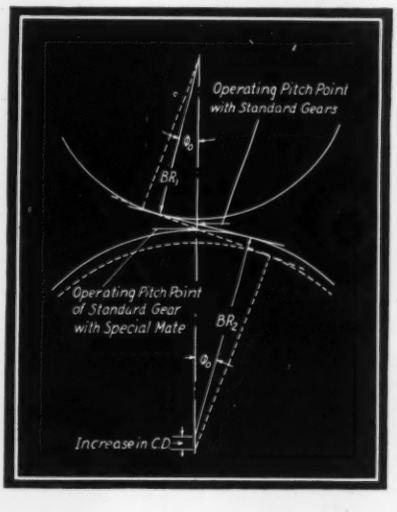


Fig. 1—Pressure line will assume a steeper position if center distance is increased

ncyof Involute Gearing

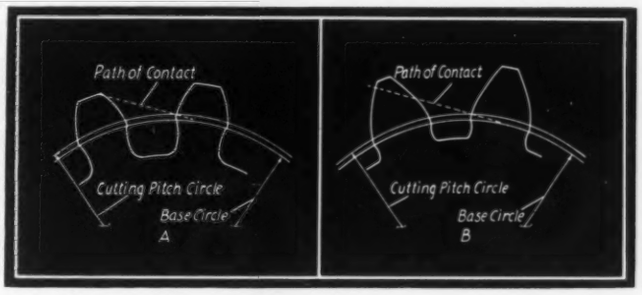


Fig. 2 — Undercutting, a characteristic of involute pinions with small numbers of teeth, as shown in A, may be reduced by designing a nonstandard pinion, B

Involute form of the teeth is not destroyed in the region of the base circle, or in other words, interference has been eliminated

Possible path of contact has been lengthened. When running with a rack the pinion will have 1.53 teeth in contact

With the pinion as driver a greater proportion of the angle of action will be in recess. This results in smoother operation

Pinion is qualified to run with any standard 1P-14½-degree gear or with any gear cut with a standard 1P-14½-degree hob

The fundamental requirement which must be fulfilled if two involute gears are to run together is that they have the same normal involute pitch. When any gear is generated by a hob or shaping cutter it is given the same normal involute pitch as the cutter. Since the special pinion was cut with a standard hob it must have the standard normal involute pitch and thus is qualified to run with any standard gear of its pitch and pressure angle and even with nonstandard gears so long as they have been generated with standard cutters.

The normal involute pitch of a standard hob or cutter is

$$N.I.P. = (\pi/P)\cos \phi_H$$

where

P = pitch number or diametral pitch

ϕ_H = pressure angle of hob

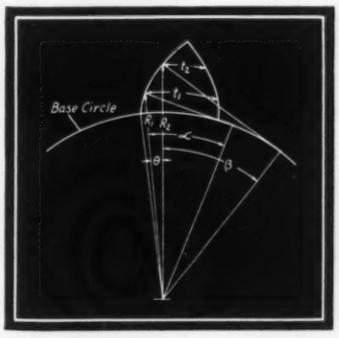


Fig. 3—The thickness of an involute tooth at any radius may be calculated if the thickness at a given radius is known

The normal involute pitch and the number of teeth in a gear determine the diameter of the base circle which may be expressed as

$$D_b = N.I.P. \times N_G/\pi = N_G \cos \phi_H/P$$

where N_G equals number of teeth in gear. Since the normal involute pitch of the special pinion is standard or equal to that of the hob with which it was generated, the diameter of the base circle also must be standard. Thus the standard gear of Fig. 2*A* and the special gear of Fig. 2*B* have the same cutting pitch circles, identical base circles and tooth forms which are portions of the same involute curve. The only difference is that the special pinion tooth utilizes a longer section of the involute curve than does the standard tooth.

From the foregoing, the general statement may be made that any gear cut with a standard involute hob will have the standard normal involute pitch, a standard base circle and teeth of standard involute form. In addition, such gears will be capable of operating with all standard gears of the same pitch and pressure angle and with all special gears which have been cut with the same hob, within the practical limits of the number of teeth in contact, clearance, etc.

Greater Center Distance Needed

If a special or oversize pinion is to run with a standard gear the pair must be mounted at a center distance which is greater than standard. Since the base circle of the special pinion is of normal size, this increase in center distance increases the separation of the pinion base circle from that of the mating gear. The path of contact and direction of tooth pressure (neglecting friction) are determined by a line which is tangent to the base circles of the mating gears, and thus if these circles are given an added separation because of an increased center dis-

tance the pressure line will assume a steeper position. In other words, the operating pressure angle will be greater than normal when a special pinion runs with a standard gear. Fig. 1 shows in full lines the base circles and line of action for two standard gears, while the dotted lines show the base circle and line of action for a long addendum pinion running with a standard gear. Operating pressure angle is controlled by center distance and base circle radii.

$$\cos \phi_o = (BR_P + BR_G)/C.D.$$

ϕ_o = operating pressure angle

BR_P = base circle radius of pinion

BR_G = base circle radius of gear

$C.D.$ = center distance

This equation may be rewritten

$$\cos \phi_o = (N_G + N_P) \cos \phi_H \div (2P \times C.D.)$$

where N_P equals number of teeth in pinion. The special pinion, having been cut with a standard hob, will run with a rack at the regular pressure angle. With large gears the pressure angle will approach the normal value, but as the mating gear becomes smaller the operating pressure angle becomes increasingly greater than standard. A few representative figures are given in the following for the 12T pinion of Fig. 2*B*.

Mating Gear	Operating Pressure Angle
Standard rack	14½°
Standard 60T gear	17°17′
Standard 32T gear	18°48′
Special 12T gear (duplicate of pinion)	26°46′

Changes in operating pressure angle are mainly of theoretical interest since gear action is not appreciably affected by changes between 14½ degrees and 20 degrees.

If no backlash is to exist the width of a tooth space at the operating pitch circle must be equal to the thickness of the mating tooth measured on its operating pitch circle. With a standard gear the operating pitch circle is always the same, so long as the mate is standard and the center distance normal. This pitch circle has a diameter equal to N/P. Further, in standard gears cut with no backlash the thickness of tooth at the pitch circle is equal to the width of tooth space and may be calculated as $\pi/2P$.

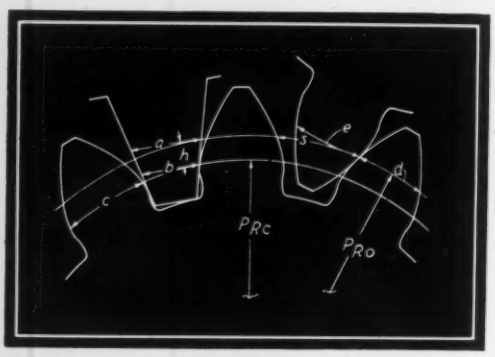


Fig. 4—To obtain thickness of tooth it is necessary to begin with the hob

When a special pinion runs with a standard gear these relations are altered. A special pinion has no definite operating pitch circle, for the diameter of the pitch circle changes with each new mating gear. If the operating pressure angle has been calculated the operating pitch circle diameter may be obtained from

$$P_D = 2BR/\cos \phi_o$$

where P_D equals operating pitch diameter. This value is also obtained from the relation

$$P_D = 2C.D. \times [N_P/(N_P + N_G)]$$

The changing values of operating pitch circle diameters cause special pinions to operate with varying amounts of backlash when mating with gears of different sizes. If a special pinion is generated with a hob it will operate without backlash when running with a standard rack. When mating with a large gear a small amount of backlash will exist provided both gear and pinion have been cut to standard depth and this amount will increase as the size of the mating gear is reduced. A few examples are given for the 1-pitch pinion of Fig. 2*B*:

TABLE I

Diameter Increments for 1P Gears with 14½° Pressure Angle

No. of Pinion Teeth	Diameter Increment	No. of Pinion Teeth	Diameter Increment
10	1.3731″	21	0.6835″
11	1.3104	22	0.6208
12	1.2477	23	0.5581
13	1.1850	24	0.4954
14	1.1223	25	0.4328
15	1.0597	26	0.3701
16	0.9970	27	0.3074
17	0.9343	28	0.2447
18	0.8716	29	0.1820
19	0.8089	30	0.1193
20	0.7462		

Mating Gear	Amount of Backlash
Rack—standard	None
60T—standard	0.025″
32T—standard	0.040″

The amount of backlash which exists may be determined by the calculation of the width of the pinion tooth space at the operating pitch line and subtracting from this the thickness of the mating gear tooth measured on the same pitch circle. The thickness of an involute tooth at any radius may be calculated if the thickness at a given radius is known. Referring to Fig. 3, assume t_1 is known, then

$$t_2 = (t_1 - 2R_1\theta)R_2/R_1$$

From the properties of an involute θ is

$$\theta = (\tan \beta - \beta) - (\tan \alpha - \alpha)$$

where α and β are in radians.

To obtain the thickness of pinion tooth at some radius it is necessary to begin with the hob. The thickness of a standard hob or rack tooth at its regular pitch line is $\pi/2P$. This is the value a

shown in Fig. 4. Since to cut the special pinion the hob is mounted at a distance from the gear axis which is greater than standard, the cutting pitch line of the hob will be shifted an amount h toward the tips of the hob teeth. This amount is equal to the increase in the addendum of the pinion if the teeth are cut to standard depth or is equal to the increase over standard in the distance from the gear axis at which the hob is mounted. Hob or rack teeth have straight sides whose angle of inclination is equal to the pressure angle of the gear system. Thus the value b may be obtained as

$$b = a - 2\,h\,\tan\phi_H$$

h = increase in pinion addendum or increase over standard in the distance between the hob and the gear axis

The thickness of the hob tooth at the cutting pitch line is equal to the width of the pinion tooth space. The width of space plus the width of tooth equals the circular pitch at the cutting pitch circle or

$$c = CP_c - b$$

CP_c = circular pitch on cutting pitch circle
$= \pi/P$ when standard hob is used

Knowing c, the tooth thickness at the operating pitch circle may be determined.

$$d = (c - 2PR_c\,\theta)\,PR_D/PR_C$$

PR_C = radius of cutting pitch circle,
$= N/P$ when standard hob is used
PR_D = radius of operating pitch circle
$= (C.D. \times N_P)/(N_G + N_P)$

Also

$$\theta = (\tan\phi_a - \phi_a) - (\tan\phi_H - \phi_H)$$

Calling ($\tan\phi - \phi$) an involute function θ may be expressed as

$$\theta = inv.\,\phi_a - inv.\,\phi_H$$

Values of the involute function may be calculated readily but can more conveniently be taken from tables published in Buckingham's *Spur Gears**. Having determined d the width of the pinion tooth space at the operating pitch line becomes

$$S = [(2\pi \times PR_D)/N_P] - d = [(2\pi \times C.D.)/(N_G + N_P)] - d$$

The backlash is equal to $s - e$, where e is the thickness of the mating gear tooth on the operating pitch circle. If this is a special gear, e may be calculated in a manner similar to that employed to obtain d. If the mating gear is standard its thickness at its normal pitch line is known and but a single step is required for e.

If backlash is objectionable in the position where the pinion is to be used, it may be eliminated either by decreasing the center distance or by cutting the pinion to give no backlash when mounted on a gear tester at the desired center distance. Taking the 1-P, 12T—60T

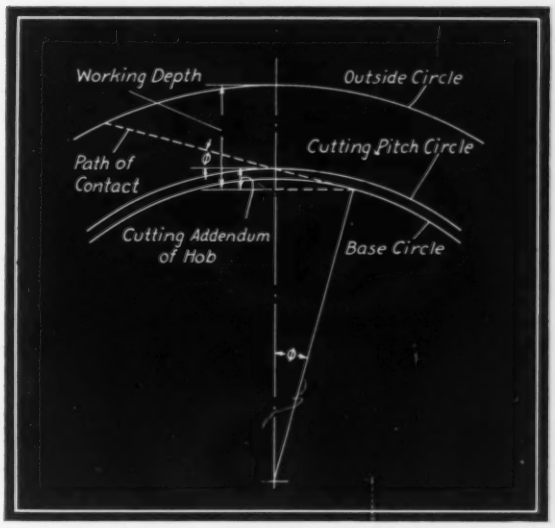


Fig. 5—Outside circle diameter to give maximum contact when mate is a standard rack

case, backlash may be avoided by decreasing the center distance 0.041 inches. Employing the second method, the pinion tooth would be given a thickness great enough to eliminate backlash if, in cutting, the hob was fed in 0.048 inches less than normal depth. The limitation of both methods comes from the tendency of the gear teeth to bottom as decrease in addendum becomes excessive. This may occur when two oversize gears, both with few teeth, must operate together or where a standard gear runs with a pinion cut on an extra large blank. In such cases both gears should be cut shallow and it may be necessary to reduce the outside diameters. A quick check can be secured by calculations to determine if the backlash is negative when one or both gears are hobbed for no clearance.

The discussion of the special long addendum pinion has thus far been limited to a gear generated by the hobbing process. It might just as well have been generated in a gear shaper. In this case a pinion would be produced which would run with a 30T standard gear without backlash. When mating with a standard gear of less than 30 teeth some backlash would be present but the amount would be less than that of a hobbed pinion. On the other hand, if a mate of more than 30 teeth is selected the pinion cannot be operated with the gear unless the center distance is increased slightly or the pinion teeth cut thin by feeding the cutter in a few thousandths more than standard depth. The operating pressure angle would be identical with that of a hobbed pinion. Calculations of backlash can be made by an extension of the methods used for hobbed gears.

The example selected for Fig. 2*B* employed a blank one-tooth oversize, or a 15-inch blank instead of a standard blank of 14 inches. This se-

**Spur Gears* by Earle Buckingham, McGraw-Hill Book Co., 1928.

lection was taken mainly for convenience since it is comparatively simple to deal with even sizes. A larger or a smaller blank might have been used. In fact a blank 15.25 inches in diameter would produce a gear of less undercut than Fig. 2*B* and would permit an even longer path of contact. The size of blank which may be used is limited by the thickness of tooth at its tip. If too large a blank is chosen the teeth will come to a point before they reach the addendum circle. For instance, the limiting size of the blank which may be used for a 12T—1P pinion is 16 inches. Practically it would be wise to limit this addendum circle or blank size to a dimension less than 16 inches which will permit a reasonable tooth thickness at the tip. If pinions of greater numbers of teeth are to be cut the limit to the size of blank is greater than two

TABLE II

Diameter Increments for 1P Gears with 20° Pressure Angle

No. of Pinion Teeth	Diameter Increment	No. of Pinion Teeth	Diameter Increment
8	1.0642″	13	0.4793″
9	0.9472	14	0.3623
10	0.8302	15	0.2453
11	0.7132	16	0.1284
12	0.5963	17	0.0114

teeth and if less than 12 teeth are to be cut the blank cannot be as much as 2 teeth oversize. The thickness of a tooth at the addendum circle may be calculated, or a simple one-tooth layout will show whether or not the size of blank chosen is permissible.

If the sole purpose of increasing the diameter of the pinion blank is to eliminate undercut, avoid interference and to give the maximum path of contact, the blank diameter for full depth teeth should be determined by

$$D_I = 2PR_C \cos^2 \phi_H + 2/P$$

where D_I equals diameter permitting maximum involute action. Referring to Fig. 5 it will be noted that the pinion is cut with the addendum line of the hob passing through the interference point and is thus given the maximum path of contract when meshing with a rack. The cutting addendum of the hob is $PR_C \sin^2 \phi_H$. This amount subtracted from the standard addendum gives the amount by which the pitch radius must be increased. The number of teeth in contact can be determined by dividing the length of path of contact by normal involute pitch.

To avoid undercut and interference in a pinion an oversize blank was used. If an undersized blank had been used these two characteristics would have been accentuated. However, if a gear of a large number of teeth is being considered it is possible to use an undersize blank without any harmful effects. Such a move is sometimes desirable when ratios and center distances are to be maintained at a figure already set by other considerations. The limiting size of a blank is set by the amount of undercut which can be tolerated.

The American Gear Manufacturers association gives a table* of diameter increments to be used for 14½-degree gears, where the sum of the numbers of teeth in the gear and pinion is 64 or more. If the pinion addendum is increasd in accordance with the recommendations of Table I, full involute action or the maximum involute action possible with a standard center distance is obtained. To permit the use of a standard center distance the diameter of the mating gear is reduced an amount equal to the increase in the pinion diameter. The gear is thus of the short addendum-long dedendum type, while the mate is a long addendum-short dedendum pinion. Table II gives values of diameter increments for 20 degree — 1P gears. In this case the sum of the teeth must be 35 or more to permit the increment to be subtracted from the gear diameter and added to that of the pinion.

From this discussion the designer will find three characteristics of the special, long addendum-short dedendum pinion especially important.

First, the special pinion, due to the elimination of undercut, has a structural strength much greater than that of a standard pinion and will thus permit the design of gear trains in which the pinions are not the weakest links in the mechanism.

Second, the elimination of interference and the increase in the path of contact will increase the number of teeth in contact. This will aid the continuity of tooth action and will produce smoother operation of the gears.

Third, the normal involute pitch of the special pinion is standard and thus it can run with any standard gear or any special gear which has the same normal involute pitch.

From the production standpoint two characteristics of the special pinion stand out.

First, the pinion may be generated with a standard cutter in a standard machine by employing standard methods.

Second, the special pinion is an involute gear and thus the basic rack of the system has straight sides. Hobs and grinding wheels for cutting the pinion will have simple forms which may be obtained with accuracy and reasonable costs.

*These values have been adopted at American standards and now are published by American Standards association, New York.

Precise Control Is Possible with New Hydraulic Valves

By Allen F. Clark
Associate Editor, Machine Design

DEVELOPMENT of hydraulic equipment for the transmission of power requires a number of basic units which may be combined to secure a wide range of results. Hydraulic drives and their attendant controls, offering extreme flexibility of feeds, sequence of motion and similar drive characteristics, have been increasing rapidly in popularity and it therefore is natural that there have been brought out a series of standard pumps, valves, etc., which furnish an exact answer to the designer's needs.

The first unit to be developed necessarily was a satisfactory pump. Vane type pumps have been produced which have proved commercially successful for pressures up to 1000 pounds per square inch. Another design is of the high speed, rotary, radial-plunger, oil pressure type in which all working parts are incorporated in a double rotor arrangement. A system in which a spoke type rotor operating on an eccentric center meshes with an idler to form a barrier between ports has been found to be practical for pumps employed in automatic broaching and drilling machines, turret lathes and similar machinery. Such a pump is equipped with ball or roller bearings and is capable of working against 300 pounds constant pressure and 500 pounds intermittent service. Ports are opposite one another, eliminating specification of right or left hand, and the pumps are reversible in operation.

After development of a unit for supplying the source of power, directional control was the next step. This usually is accomplished by a longitudinal shifting 4-way valve of balanced design. With employment of a latch-controlled valve of this type, the operator starts the machine and the valve operates it through one complete cycle. This latter type is particularly adapted to press operation, hydraulically operated furnace installations, etc. Three-position valves are also available which provide a neutral point between forward and reverse positions where the pump is by-passed at no pressure while both outlets are completely closed.

With directional control built into the machine,

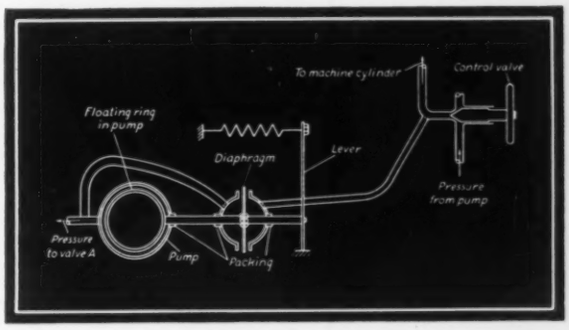


Fig. 1—Diaphragm type hydraulic valve maintains a constant pressure differential

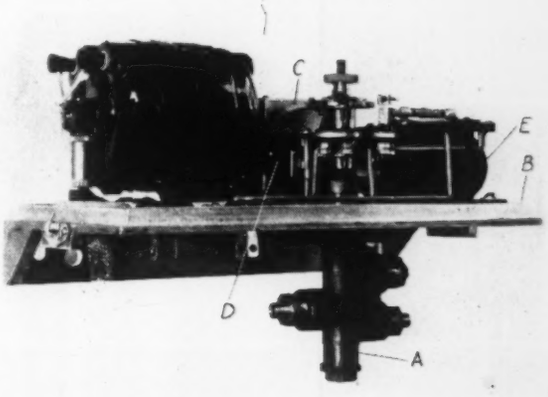


Fig. 2—Accurate control is enabled by solenoid arrangement working through a gear train

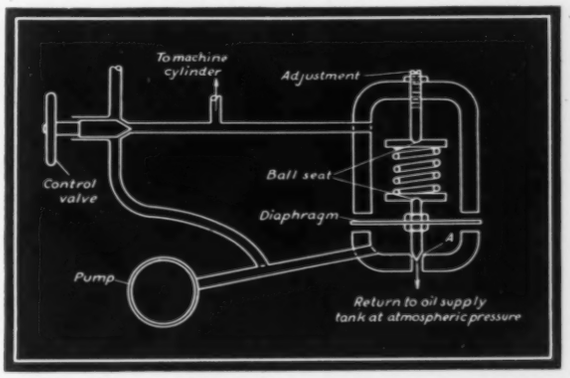


Fig. 3—Valve regulates pressure from an ordinary gear pump of constant discharge type

some means must be provided for preventing the pressure from exceeding the desired amount. Among the methods in general use for accomplishing this result are a pressure controlled method of reducing the pump output and a safety or relief valve. Volume control has been built into the design of some types of pumps, Fig. 8. The pump control operates by holding the pump stroke at neutral as long as pressure is sustained. It incorporates an hydraulic piston which is connected to the stroke-shifting ring of the pump. The action of this piston is opposed by a spring which has a tendency to pull the shifting ring into maximum full stroke at all times.

Control Sensitivity Important

In the loading systems of hydraulic machines sensitivity of control is of great importance. The method of securing this sensitivity may be of value to designers of other machines as will other details of the controls on testing equipment. Controlling the discharge of the pump will permit an unbroken gradation of speed variations from zero to maximum. A sensitive discharge control must be available and this discharge at any fixed amount must be constant under pressures which vary from zero to maximum in any test.

In the manually controlled machines, a main control wheel is provided for displacing the floating ring of a rotating cylinder pump. In smaller machines, however, a difficulty arises from the fact that there is a minute amount of oil leakage in the cylinders directly proportional to the pressure. This amounts to only 4 per cent of full discharge or less and ordinarily could be neglected except where extremely slow speeds of the movement of the ram are required.

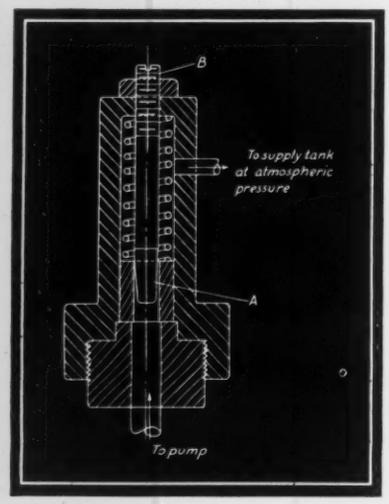


Fig. 4—As the pressure increases the spring-loaded plunger will move upward to reduce amount of fluid entering

To overcome this loss an automatic adjustment wherein a balanced valve operates under differential pressures has been developed. Whenever the balance becomes disturbed by leakage in the pump, the valve stem automatically moves over and acts directly on the floating ring of the pump, increasing or decreasing discharge the required amount. The valve, shown diagrammatically in Fig. 1, is a diaphragm type hydraulic valve which maintains a constant pressure differential across the manual control valve of the testing machine, automatically giving constant discharge under varying pressure without hunting or any visible adjusting effects.

Pressure Will Be Maintained

With the machine valve *A* closed, pressure will build up on the left side of the diaphragm and move the floating ring to zero discharge position or to a position near zero—only enough fluid being discharged to compensate for leakage. Due to the spring, the predetermined pressure differential across the diaphragm and across valve *A* will be maintained even though the pressure on the machine side of valve *A* is atmospheric. When valve *A* is opened to admit fluid to the machine cylinder, pressure on the left side of the diaphragm drops and the spring shifts the floating ring to the left to increase the pump discharge and to regain the pressure differential. Constant pressure differential (manually variable between limits by adjustment of the spring) across valve *A* means constant volume of fluid passage and constant velocity of ram movement. It is possible to maintain constant velocity of ram independently of load on the ram within the machine range.

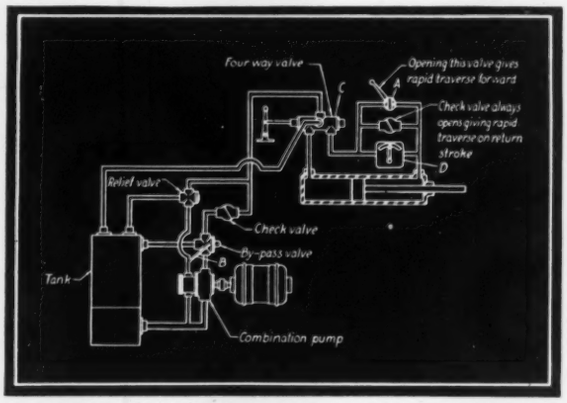


Fig. 5—Control of volume is a feature which should be built into hydraulic drives

Special Valve Required

Because the variable-discharge pump system is more or less expensive, an ordinary gear pump of the constant discharge volume type was employed on another machine. It is necessary in this case to provide some special hydraulic valve to care for the excess discharge when it is not needed by the ram in the machine load produc-

ing cylinder—the ordinary and usual condition on this particular application. The valve employed, schematically represented in Fig. 3, like the one shown in Fig. 1, must maintain a constant pressure differential across the control valve, but it must do it by by-passing the excess.

When the control valve is closed the pump pressure raises the diaphragm against spring load until the predetermined pressure differential is achieved — the oil by-passing through valve opening *A*. The loss of head through this opening determines the pressure and, therefore, the pressure differential (assuming the cylinder of the machine open to atmospheric pressure by the auxiliary by-pass and relief valve supplied with this type of machine). Opening the valve to admit pressure to the cylinder of the test machine means a rise in pressure on top of the diaphragm together with a partial closure of the valve opening and a re-establishment of the pressure differential. Thus with a radically different system and type of pump from that described in the foregoing, a constant rate of ram motion through a constant time-rate of volume passage is again accomplished.

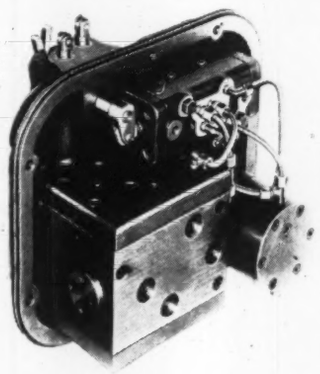


Fig. 6—Directional control as well as control of the various phases of the cycle can be obtained with this panel

Precise Control Is Secured

Volume control is the most important additional requirement encountered in the later stages of designing hydraulic equipment. One method of securing precise control is illustrated by Fig. 5. Oil from the pump unit is supplied to the 4-way valve *C* which, when shifted to the proper position, supplies oil under pressure to the left-hand side of the cylinder, causing the piston rod on the right-hand side to move outwardly. The escaping oil from the opposite side of the piston is allowed to move freely when shut-off valve *A* is in the open position, allowing the piston to travel at a rate dependent upon the full pump volume available to fill the opposite side of the cylinder.

The closing of this valve, usually accomplished by a stop on the moving member, necessitates that the escaping oil pass through valve *D*. It is obvious that if a simple valve orifice is used at this point flow will vary according to the pressure operating against this orifice. Such a condition would allow varying rates of oil escapement dependent upon variations in pump pressure or resistance encountered by the piston rod. It therefore is necessary that a valve be used which is not subject to these variations.

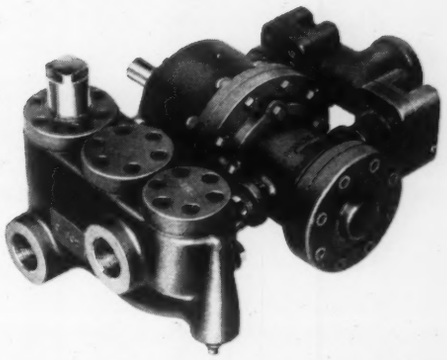


Fig. 7—Unit combines two pumps and several valves to make a complete drive arrangement

Chatter Is Eliminated

The valve shown in Fig. 5 incorporates a pressure-compensating device which maintains a constant pressure drop of small value across a manually variable valve orifice. The controlling of the escaping volume is especially advantageous due to the fact that the piston is then advanced between two opposing pressures. This condition prevents the possibility of chatter or surge occurring, which is a condition usually encountered in machine tool practice. It is obvious from the above description of a cycle, that a considerable variation in oil demand will be experienced if any considerable ratio of rapid approach to feed rate should occur. Therefore, it is desirable to eliminate the wastage of power which would result if a single pump of sufficient volume were supplied as a single unit.

As an example, during the rapid approach movement, a volume of 20 gallons per minute might be required at a pressure of 150 pounds per square inch, whereas a pressure of 700 pounds might be required during the slow moving period of the cycle and the volume requirement might be 1 gallon per minute. If the large pump were operated at 700 pounds and the excess by-passed over the relief valve, wastage of approximately 7 horsepower would occur.

For this reason a combination of two pumps has been developed, the larger unit of which is controlled by a suitable by-pass valve and the smaller portion limited by a suitable relief valve. A check valve is placed between the by-pass valve and the junction with the high pressure

line. As applied to the foregoing example, the by-pass valve would be adjusted for operation at a pressure of 150 pounds, and the relief valve would be adjusted at a pressure of 700 pounds. When, in the process of a cycle, valve *A* is closed, pressure will immediately rise in the system to the restricted demand for fluid. This rise in pressure operates the by-pass valve through the small line *B*, opening it completely and allowing the volume of the large pump to circulate at zero pressure. The check valve closes, preventing the loss of high pressure and the small pump supplies the high pressure during this period of operation. The power required is consequently reduced to the amount necessary to operate the small pump at 700 pounds per square inch and the large pump at zero pressure, which in practical use would amount to approximately 1½ horsepower. The circuit shown is diagrammatic, and the example given is typical.

Leakage Becomes Important

Because of the extremely small quantities of fluid needed in the operation of testing machinery under certain conditions, leakage of fluid from the load producing cylinder becomes an important factor in the maintenance of a constant velocity of ram. This is particularly true of the lapped ram types and even more so of the lapped ram types having rotating cylinders.

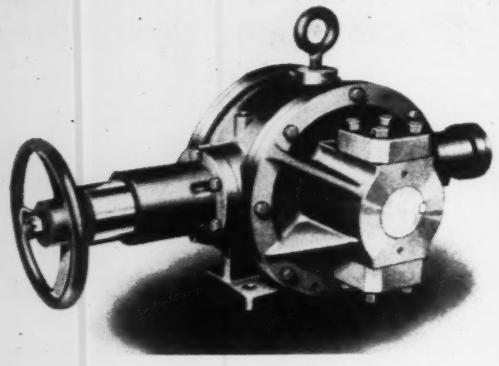


Fig. 8—Volume control may be built into the design of the pump to be employed

Therefore it is necessary to provide a valve which compensates for this leakage. Such leakage is nearly proportional to the pressure, so it is necessary to provide an adjustable valve the leakage of which varies as the pressure, Fig. 4 As the pressure increases the spring-loaded plunger *A* will move upwards due to increased pressure differential between the upper and lower faces and reduce the amount of fluid flowing in the annular space between the valve stem *B* and plunger *A*, thereby accomplishing the desired result of leakage volume inversely as the pressure.

The valve used on a recorder-controller, though not in itself unusual, employs a mechanism for controlling its rotation which is unique and may prove of value to other designers. Fig 2 shows the valve *A* and the mechanism above table *B*. The fine-tooth bevel gear *C* runs continuously. Two pinions, one of which is shown at *D*, are normally out of mesh. A solenoid *E*, controlled through relays by extremely small currents through contacts associated with the machine apparatus, pulls one or the other of these pinions into mesh and rotates through a worm reduction the valve spindle which varies the port opening and, therefore, the movement of the machine. This control is so sensitive that motions as small as 0.0001 inch per inch gage length per hour may be achieved. This means ram motions of the order of 0.0004 to 0.0010 inch per hour.

Several Units Are Combined

For commercial use a pump has been developed as illustrated in Fig. 7 which incorporates a large volume pump, small volume pump, by-pass valve, check valve and high pressure relief valve. The unit as shown in Fig. 6, is a panel typical of a number of types available for accomplishing directional control as well as control of the various phases of a cycle, such as rapid traverse, feed, dwell and rapid return. In this unit the feed rate is also variable by the use of mechanical stops or dogs, and in the event of interrupted cuts, rapid traverse may be secured between two cutting positions. Many other types of circuits are available in panel or unit form and more unusual cycles may be developed from separate valve units. The manufacturers of hydraulic equipment should be consulted when it desired to develop a circuit having any unusual characteristics.

For their assistance in co-operating in the preparation of this article and for the illustrations used, MACHINE DESIGN wishes to thank the following manufacturers: Baldwin - Southwark Corp., Philadelphia; Hydraulic Press Mfg. Co., Mt. Gilead, O.; Vickers, Inc., Detroit; and Viking Pump Co., Cedar Falls, Ia.

Articles on this and similar subjects published in previous issues of MACHINE DESIGN include:

"Hydraulics in Design," by John P. Ferris, March, 1930, p. 27, May, 1930, p. 35, and June, 1930, p. 26.

"Applying Hydraulic Principle in Loaders and Conveyors," by John Merck, Aug., 1930, p. 19.

"Hydraulic Transmissions Introduced," Sept., 1930, p. 30.

"Unusual Mining Machine Eliminates Blasting Hazard," by Harold B. Veith, Oct., 1931, p. 25.

"Thrust Unit Has Numerous Design Applications," by Allen F. Clark, Oct., 1931, p. 45.

"Hydraulic Ram in Ship Design," Nov., 1931, p. 23.

"Hydraulic Drive Must Incorporate a Slippage Factor," by Carl Morey, Feb., 1932, p. 35.

"Making the Most of Hydraulics," by Carl Morey, March, 1932, p. 32.

"Hydraulic Transmissions in New Applications," by Carl Morey, Sept., 1932, p. 27.

"Correcting for Fluid Compressibility in Hydraulics," by James I. Clower and Harold F. Shepherd, Nov., 1932, p. 24.

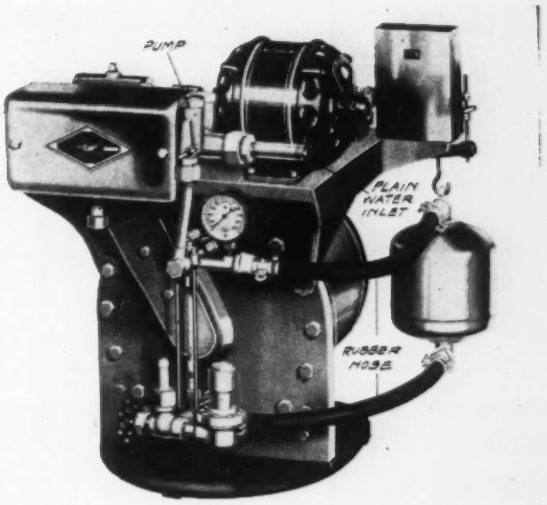


Fig. 1—Stainless steel and brass prevent premature destruction of carbonator parts by erosive action

Stainless Steel Overcomes Erosion Problem

By J. Kantor
Chief Engineer, Liquid Carbonic Co.

MACHINES used in the manufacture of carbonated water, commonly called "soda water," vary in size from 20 gallons per hour capacity to 1000 gallons per hour. However, the design employed throughout this range is essentially the same. In discussing the erosion and mechanical problems confronting the designer of these carbonators, we will use the 20 gallon size, Fig. 1, a size employed in connection with 95 per cent of all the soda fountains in the country. Before going into the details of the design problems, it probably would be advisable to present a brief review of the manufacture of carbonated water.

When carbon dioxide and water are brought together in an open container under atmospheric pressure or in a closed container at pressures higher than atmospheric, some of the gas is absorbed by the water and the latter is said to be carbonated. The degree to which water is carbonated depends upon the temperature of the water and the gas pressure imposed. At atmospheric pressure and a temperature of 60 degrees Fahr., distilled water will absorb an amount of carbon dioxide or carbonic gas which, at that pressure and temperature, will have the same cubical content as the water. At a constant temperature and under any pressure up to 75 pounds the amount of carbon dioxide that water will absorb is directly proportional to the pressure. Beyond 75 pounds the additional amount of gas absorbed continually decreases until the saturation point is reached.

The carbonator consists essentially of a body for storing the carbonated water, a water pump, a motor for driving the pump, and automatic means for starting the motor when the water in the body is at a predetermined low level and stopping when the high level is reached. The machine is fully automatic in every respect and requires little attention after it is in operation.

The fully automatic carbonator was first introduced in 1895, prior to which all carbonators were hand powered, that is, the tank was turned back and forth by means of a handwheel, the idea being to agitate the water and the gas so as to bring about more readily the absorption of the gas by the water. The tank was cylindrical, made of gun metal bronze in two halves bolted together.

Care Necessary in Forming

Following the introduction of pure sheet tin, the bronze carbonators, which were heavy, cumbersome and expensive, were discarded. Since pure tin was more immune to the erosive action of carbonated water, the bodies of the carbonators were redesigned to be cast of iron and lined on the inside with sheet tin about 1/16-inch thick. While tin is still used on many carbonators built today, it is not a cure-all, nor is it entirely immune to the erosive action of carbonated water. Tin is quite malleable and care must be exercised in handling it as it punctures easily. Occasionally a carbonator which has been in operation for only a short time will be found in

which the tin lining has collapsed. This usually is due to an invisible pin hole in the sheet tin through which carbon dioxide accumulates to the full carbonator pressure between the lining and the cast iron body. When the carbonator is drained, the pressure of the gas within the body is reduced faster than the pressure of the gas which is between the liner and the shell. The result is that this higher gas pressure causes the lining to be bulged inward and away from the shell.

It has been found that in the localities where the water is high in mineral content that a block tin lining does not last long. The cause is electrolysis, greatly accelerated by the high mineral content which makes the water a better electrolyte. An examination of the inside of a carbonator the tin lining of which has been eroded will reveal numerous white cones covering the lining. Chemical analysis shows these to be one of the oxides of tin.

Stainless Steel Introduced

Stainless steel, now used throughout in the manufacture of carbonators by leading builders, solves the many problems presented by tin, reduces the cost of manufacturing, is more sanitary, and materially increases the life of the units. The body of the carbonator is now spun and drawn from a 3/32-inch thick polished stainless steel sheet, the polished side on the inside. This item alone considerably reduced the cost, cut down the weight and enabled a more pleasing appearance. The head is cut to shape from hot rolled steel by a special oxyacetylene torch operated from a master pattern and this head is lined with polished stainless steel sheet 1/32-inch thick. The fittings, formerly cast brass tin plated by the hot process, are now brass forged and electrotinned. The agitator on the inside of the body which heretofore was die cast from pure tin now is stamped from polished stainless steel sheet.

Substitution of materials was also found advisable in the design of the agitator shaft and bearing housing, now made of 18-8 stainless steel. The design of the agitator shaft bearing presented a problem as regards the proper bearing metal to use, since a stainless steel shaft running in a stainless steel bushing would sooner or later "freeze," even though water lubricated. The bearing metal used has to withstand the action of the carbonated water and be sufficiently softer than the steel shaft to make a good bearing. After much experimenting and research, Everdur was found to be best suited for this bearing.

Die casting is employed for the worm drive housing as it gives a housing much tougher and less expensive. As a substitute for the usual packing for the worm and worm wheel shafts, commercial oil seals of the inverted cup leather type are employed. Since these seals are practically frictionless, they materially reduce the motor load. The worm is hardened and ground and is integral with the shaft. The worm wheel, which heretofore was made from phosphor bronze, is now an aluminum bronze alloy, an alloy chosen because of its increased life in this service. Ball bearings are now employed as a step toward reducing friction and lessening the motor load.

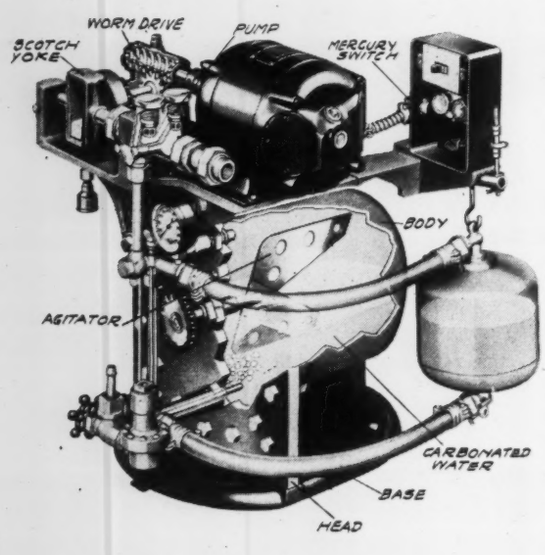


Fig. 2—Complete redesign was necessitated by nature of the liquid handled by this machine

Brass Forgings Employed

The water pump also came in for its share of attention when redesigning to overcome the erosion problem. As in the case of the fittings, a brass forging, electrotinned, was substituted for the previous cast brass part. Special rubber seats, more durable and absolutely noiseless, now are used on the check valve of this pump.

Prior to the introduction of the stainless steel parts, considerable experimenting was carried on with glass lining, that is, the body of the carbonator was lined with a thin layer of glass. While glass withstood the erosive action of carbonated water, it was not entirely practical as much trouble was experienced when tightening the bolts holding the body flange to the cover. It seemed as though even the slightest uneven tightening of the bolts would cause the glass lining at the body flange to chip. Much care and consideration had to be given the design of castings which were to be glass lined. A liberal radius had to be resorted to and deep and abrupt pockets dispensed with. In spite of this, cracking of the glass lining would occur due to internal strains. Therefore it can be seen that redesign using the newer types of metals proved advantageous from the production, efficiency and economy standpoints.

Consider Finish During Design To Reduce Costs!

By S. P. Wilson

SINCE the adaptation of nitrocellulose lacquers to the finishing of automobiles in 1923, steadily increasing quantities of these materials have been used in all industrial fields. Machine tools, washing machines, refrigerators and innumerable other devices have been finished in large production with this quick-drying, hard, tough and durable finish. In superseding the previously used oil paints and enamels, lacquers naturally created problems of their own, but it did not take long for finishers to learn to use them with considerable facility.

From the standpoint of a designer of machinery the finish is naturally the last point considered. The lines and dimensions of the article, the materials used, possibly the colors, are determined beforehand. Then after the object is completely designed the choice of finishing material is made, and the paint, enamel or lacquer specified which apparently best covers with least expense.

DETERMINATION and specification of the finish to be used on a machine while the design is still in the blueprint stage will result in considerable saving of production costs. Dr. Wilson, Varnish Products Co., Cleveland, points out some of the design points that will facilitate a better finish and a better part.

Much of this is inevitable, yet there are points that can be taken into consideration in the blueprint stage that will be invaluable both from a standpoint of appearance and from that of economy when the article comes to the finishing room.

Materials Choice Important

For example, let us consider choice of materials. Much cast metal is used where pressed steel would be equally serviceable. The difficulty of securing a lacquer finish on cast iron is much greater than on smooth steel as fillers, surfacers and sanding operations are necessary to bring the rough porous surface to the necessary smoothness. A lacquer film is much thinner than a corresponding oil paint film, and will not fill depressions as well. On the other hand, its speed of drying and hardness, oil and water resistance, and durability may make its use desirable. Therefore, if the designer incorporates into his design the necessary choice of smooth metal, if otherwise suitable, expense and trouble are saved in the final operation.

Again, lacquers are generally sprayed, though many small projects and some large ones are dipped, an appreciably cheaper method. In many cases a slight change in design will permit of dipping an article which otherwise would require spraying. One company was having considerable difficulty in getting a smooth finish on stamped steel parts by dipping, as an ugly run occurred where the sides were attached to the body by lugs. The lacquer ran off the lugs after the body was set leaving an irregular sag in the finish. Changing the assembly to have

the edge of the lug run perpendicularly to the base instead of parallel practically eliminated the trouble. Objects with rounded edges dip much better than those with sharp ones—often the edges could just as easily be rounded, thus permitting more economical finishing.

In general, lacquer requires a cleaner surface than ordinary oil finishes. Traces of grease or oil hinder adhesion greatly, and although methods of cleaning have been greatly improved in recent years the designer can well assist in this important procedure. If the object has blind crevices, moldings, etc. where pickling or plating fluids, drawing compounds, grease or other undesirable material can accumulate, either over-expensive cleaning or poor adhesion of finish will result. With this in mind, it often will be possible to design an article so as to avoid the difficulty and leave only easily reachable surfaces.

Akin to this is the difficulty encountered when lacquer finishes are applied over cast iron housings or crankcases in which lubricants are to be placed. These seep through the pores and attack the lacquer finish from beneath. Where cast metal must be used for this purpose it is wise to protect the finish by specifying a coat of a lacquer generally known as "crankcase sealer" to the interior of the housing. This will seal the pores and prevent the seepage of oils and greases.

Prefinished Sheet Is Projected

Another factor that will soon be of importance to designers will be the advent of prefinished sheet metal. Two processes are in view, one wherein the finish and ornamentation are applied mechanically directly to the metal sheet and another in which it is applied first to a decalcomania transfer which is later applied to the sheet. In either event, sheet steel with a complete finish that will withstand practically all needed forming, stamping and cutting operations will soon be available. Since it is much more economical to stamp an instrument board, for instance, out of a prefinished sheet than to prime, grain, lacquer and rub and polish each irregular piece singly, great economy as well as an improved appearance is possible. However, one defect appears which will require designing ingenuity to overcome. The welding of lacquer finished parts is impracticable, lacquer being a good insulator that is easily damaged by welding temperatures. New methods of assembling parts will be required whereby it will not be necessary to weld through finished portions.

In conclusion, it may be well to define a lacquer. It is a combination of nitrocellulose, resins, softeners and the necessary solvents, clear or pigmented, which dries by evaporation of the solvents, generally within one-half hour, instead of by oxidation and polymerization of the oils as do the oil enamels required. When the solvents are gone, a hard, water, oil and abrasion-resistant film results which has proved a blessing in production to innumerable industries.

Articles on this and allied subjects presented in previous issues of MACHINE DESIGN include:

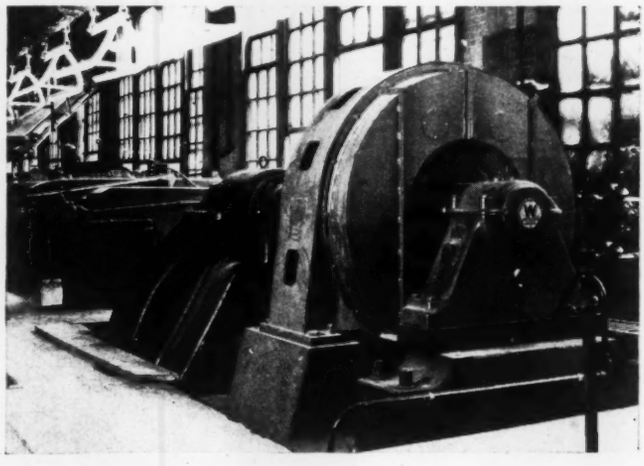
"Metallic Coatings Combat Corrosion and Provide Attractive Finish," by Gustaf Soderberg. April, 1933, p. 18.

A listing of earlier articles is given on page 58 of the April, 1933, issue.

Powerful Motor Is Easily Stopped

ENERGY sufficient to lift a modern passenger elevator loaded with 12 passengers to a height of 24 stories is required to stop the rotating element of a new thousand-horsepower motor used to operate the huge rolls of rubber mills. The rotating element of this powerful motor, which can be brought from full speed to a dead stop in one and one-quarter seconds or three and one-half revolutions, weighs more than three tons and turns with a speed of 514 revolutions per minute.

Dynamic or electrical braking is the secret of the motor's ability to stop quickly. When the stop switch is touched the motor windings are closed through resistance grids where the electrical energy stored in the rotating mass is dissipated in the form of heat.



One thousand horsepower motor can be brought from full speed to a dead stop in one and one-quarter seconds

The motor drives through gears a number of huge rolls, each seven feet long and more than two feet in diameter. The rolls must be stopped quickly in case of emergency to avoid injury to the operator as the crude rubber travels at a speed of 19 inches a second. Westinghouse engineers designed the motor for Goodyear Tire & Rubber Co.

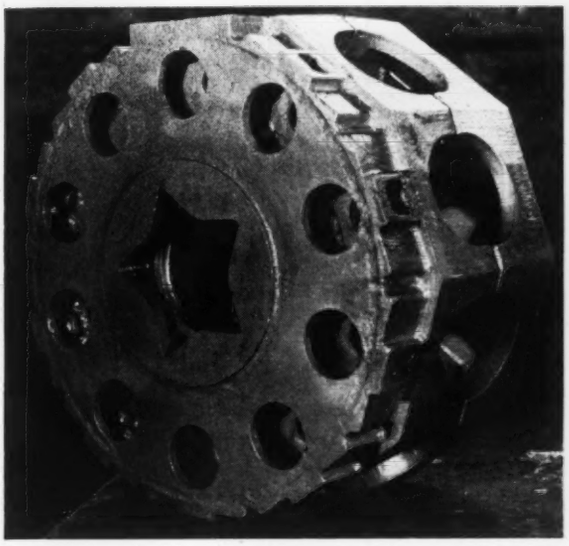


Fig. 1—Radial diesel engine with welded crankcase has exceptionally low weight for this service

Welding Brings Down Engine Weight

ONE of the factors which has prevented the diesel engine from assuming its rightful place as an important prime mover in transportation units has been its excessive weight, according to Everett Chapman, vice president in charge of engineering, Lukenweld Inc., Coatesville, Pa., who presented the paper from which this article is abstracted at the recent oil and gas power division of American Society of Mechanical Engineers. The transportation field, including marine and railroad work, has been definitely closed to the diesel engine because of its usual specific weight ratio ranging from forty to two hundred and fifty pounds per horsepower.

An application in which this weight disadvantage was overcome by the use of welded steel construction for diesel crankcases is illustrated in Fig. 1. This part is a crankcase for a 10-cylinder 600-horsepower radial engine, and is constructed in welded steel, using as the base metal a high strength alloy steel. All weld metal specimens deposited with the alloy electrode used to fabricate this case have a yield point of 65,000 pounds per square inch, an ultimate strength of 95,000 pounds per square inch, and an elongation in two inches of 24 per cent. The main loads are carried by a weld and it is only necessary to pay strict attention to all the design details to insure that such a case will exhibit satisfactory performance.

Castings Are Employed

Attention is called, in Fig. 1, to the use of steel castings to form the periphery of the cam pocket. The contours involved around the push rod guide bushing and the bolts tying the two halves of the engine together were sufficiently intricate to dictate the use of a steel casting. The parts were cast in units of one per cylinder and the entire casting assembly welded into one ring, which was inspected and machined before welding it into the rest of the assembly. In an application such as this, it is essential that the carbon content of steel castings be maintained below 0.20 and that the castings be of the finest grade obtainable. Electric furnace castings are highly desirable for use in welded steel assemblies because of the close control over both pouring temperature and analysis. The small amount of dissolved gases present offers favorable welding characteristics.

Welded steel crankcases of the type discussed enable the engine builder to offer to the user of mobile prime movers a light weight, highly efficient and powerful unit, embodying all the advantages of the diesel principle. Winton Engine Corp., Cleveland, with which it has been a privilege to work in the development of welded steel structures, can offer today an engine-generator unit supplying 750 kilowatt of electrical energy which, including all auxiliaries, will weigh 30 pounds per horsepower. Railroad vision has enabled immediate application of this notable prime mover to main line service. Under construction today is a welded steel engine which will be used in the power unit of the Union Pacific System's 110-mile per hour high speed passenger train.

Some progressive railroad will undoubtedly take the next step and employ two or three of these units on a single chassis for main line freight movement at an economy never before approached.

MACHINE DESIGN

L. E. Jermy, Editor
Allen F. Clark
Harold B. Veith
F. H. Burgess

Ability To Accumulate Ideas Is Valuable Design Asset

REVOLUTIONARY changes in the design of transportation equipment are in progress. The railroads are experimenting with lighter and faster trains made possible by streamlining, use of new materials and improved motive power. Departures from the orthodox method of spring suspension will be introduced in the 1934 models of several automobiles. Through application of improved knowledge of aerodynamics, commercial air-transport companies are steadily reducing the travel time on the scheduled flights of their planes.

What is behind this apparent revival of interest in the speed and comfort of travel on land and in the air?

Perhaps the principal motivating factor is competition. Certainly, the present efforts of the railroads to improve their service are traceable directly to the inroads made on their passenger traffic by buses, private automobiles and airplanes. Likewise much of the improvement in motor cars and planes is due to competition for the public's transportation dollar.

However, there is a second and equally important factor, which usually is overlooked. It is the interchangeability of ideas—a recently acquired asset in modern technology—which enables engineers in one line of development to benefit promptly from the achievements of their contemporaries in other fields.

Progress is built upon accumulated experience. Today the progressive manufacturer of machines or parts is the one whose engineers know how to capitalize upon the vast pool of knowledge which daily is accumulating in the broad field of machine design.

• • •

Look Ahead!

IS SUFFICIENT being done in design to combat conditions ahead? Recent months have given an indication of the buying wave that might be released by the further passing of restrictions in income. That wave will be felt again periodically, until it reaches the proportions of boom periods. Yet with wages as high or higher than formerly, working hours undoubtedly will remain less. Consequently we are likely to see higher buying power with reduced productive capacity!

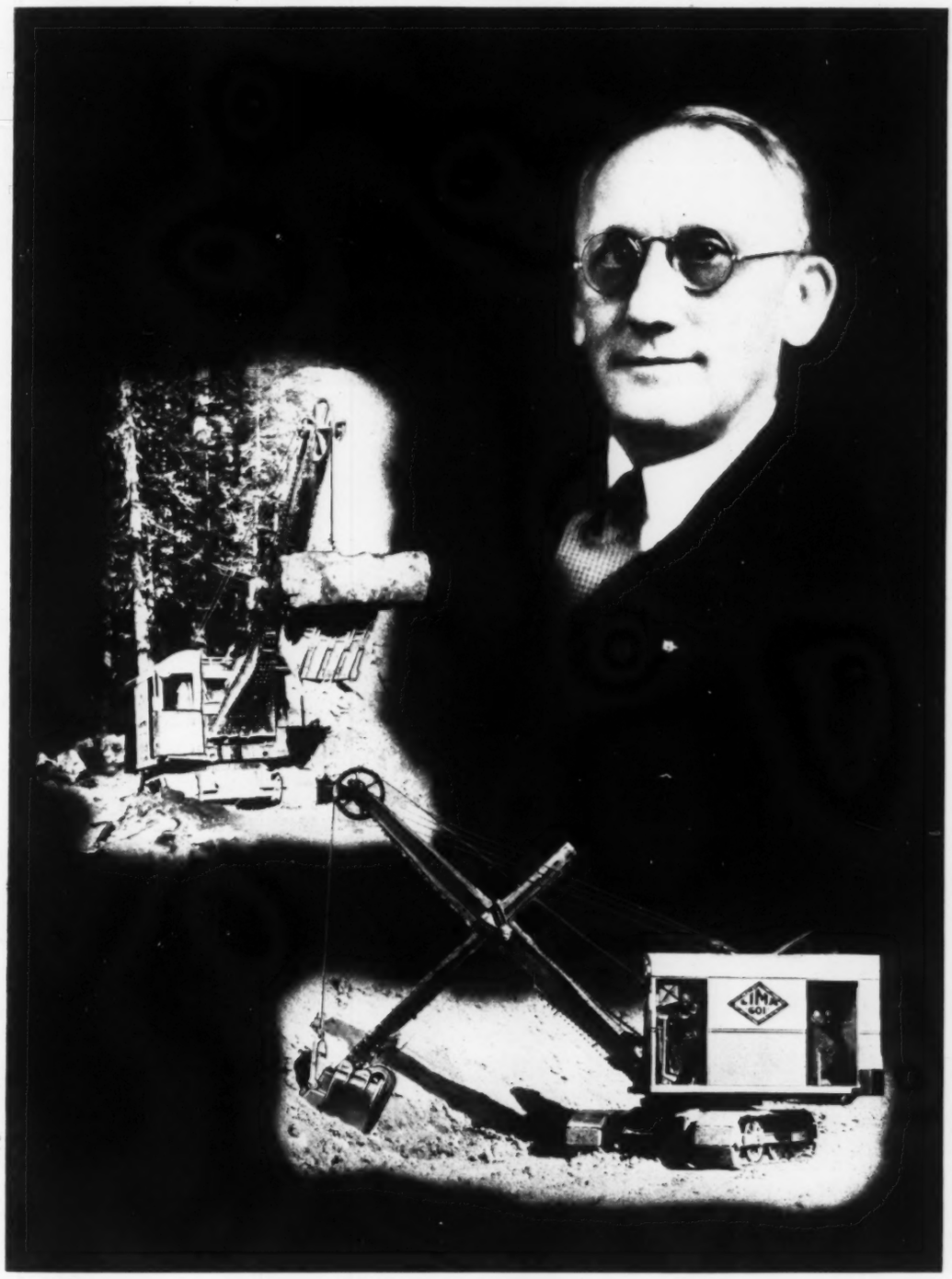
This condition necessarily means higher speed machinery. Leaders in industry agree that this is incontrovertible. Investigation reveals however, that while design work is progressing at a somewhat increased rate there still are companies that have done little toward laying out machines capable of rising to the occasion.

Sooner or later, uncertainty—the root of the trouble—will be dispelled. Those companies that are best prepared with their designs will then be more than repaid for their farsightedness.

MEN

and Their

MACHINES



JOHN D. RAUCH AND HIS POWER SHOVEL

Men and Their Machines

NOTHING appeals to John D. Rauch more intensely than an opportunity to observe the performance of his power shovels under severe service conditions. As consulting and research engineer for the Ohio Power Shovel Co., Lima, O., he has spent months on end studying his designs in the field. Recently his work outside the office has taken him into the South where the Mississippi levee project has afforded an excellent proving ground for new equipment.

"If possible, break them," Mr. Rauch tells the operators in the factory test lot. In his opinion that is the one certain way to find weaknesses . . . . he is an extremely practical engineer. Going back over his record reveals an intensive devotion to mechanical matters. Logansport, Ind., was his birthplace; Purdue university his alma mater. After he finished his sophomore year there he went on the drafting board in the motive power department of the Pennsylvania railroad. His several years in that capacity augmented his ambition to continue in design.

In 1906 Mr. Rauch organized as a partnership, the American Steel Dredge Co. in his home town for the manufacture of steel floating dredges. Three years later the company was moved to Fort Wayne and he became secretary. Many units including shovels were built from his plans.

Development in shovel design showed marked progress as a result of his ingenuity, and in 1924 he patented a power shovel equipped throughout with antifriction bearings and embodying the principle of the single line hoist. About the same time he was instrumental in organization of the Ohio Power Shovel Co. and became responsible for all its design work.

Rauch spends much time on his work—or one might say his hobby—power shovels. Ideas occur to him most readily when in secluded concentration on a specific point. Freehand sketches he finds particularly conducive to solution of a problem. In making sketches he has found it is helpful after completing several with the machine facing in one direction, to reverse the operation. This often brings out ideas that otherwise do not appear.

One of Mr. Rauch's praiseworthy characteristics is his appreciation of the value of being able to present his ideas clearly in writing. He is the author of numerous technical articles, and a member of several engineering societies.

Excavating Machinery

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments and Questions from Our Readers. Machine Design Welcomes Letters or Solutions to Problems Suitable for Publication

Specify Machine Finishes!

To the Editor:

IN YOUR September issue you published an article by R. E. W. Harrison entitled "Designer Should Specify Type of Machine Finish." It is certainly time this important procedure was universally adopted. It imposes responsibility on the designer, as is proper, and relieves the production department from assuming the finish according to their judgment.

All concerns sending out blueprints for quotation purposes should give the estimator this knowledge, and thereby definitely place responsibility for the finish upon the manufacturer. A symbol indicating the quality and kind of finish should be incorporated on drawings, and should be a part of the machine industry's code of ethical practice and fair competition.

—S. A. SMITH,
Boston

Employ a Piece Rate System?

To the Editor:

IN REFERENCE to the article on this subject the September issue, there are so many factors entering into any scheme of evaluation that it is almost impossible to write them into an equation that will fit all situations. The work of any designer over a period of time involves so many crests and troughs in his personal accomplishment that any scheme would have to provide for his failures as well as his successes. The proof of a good design often occurs long after it has been completed.

However, it is believed that the following system employed by an aeronautical manufacturer may be used with modifications to fit all existing conditions. A daily job ticket is used in the design department. Engineering costs are treated as other manufacturing costs inasmuch as they are charged against the product. Previously, time clocks had been used to record engineering time, but there appeared to be an inherent aversion to their use among the engineering personnel. The same purpose was accomplished by allowing the draftsman or designer to write in his time on the daily job ticket shown, a separate ticket being used for each job.

The job ticket system of keeping account of engineering time is usually a revelation to the executive in charge of the engineering department as to the value of the various men in his department.

	337-XP. (Schedule and Job Order No.)				
352 (Check No.)	Bennett, John. (Name)			6.00 (Pay Rate)	
Roller (Name of Part)					Idler Gear (Operation)
STOP 5.00	7/6/33			9.00 START	1 (No. Pieces Worked On)
					(Operation No.)
	Hours	Tenths	$	Cents	
REGULAR	7		6	00	FINISHED [X]
EXTRA					NOT FINISHED [ ]
TOTAL	7		6	00	T. S. Brown. (Supervisor)

Simple daily time cards assist in the setting of proper piece rate base times

To the Editor:

THE matter of a piece rate system for the engineering department brought up in your September issue is one on which I have made an exhaustive study. I am thoroughly convinced that due to the fact that many draftsmen work at about 25 per cent efficiency when working on a salary basis, the average engineering costs can be cut in half by the institution of the piece rate system.

The advantages of such a system gained by the men include: Increased earning capacity; progress measured by production; increased in-

dividual efficiency; and improved morale. The manufacturer gains: General reduction of engineering costs; elimination of nonproducers; establishment of higher grade personnel; and better supervision. There are some disadvantages, however, which would appear to include: Higher percentage of errors; difficult rate setting; and accommodating individual peculiarities of the men.

All of the benefits of a piece work system might be nullified by short-sightedness. For example, if the designers increase their production and effect a corresponding increase in salary, it would be fatal to the system for the manufacturer to cut the basic costs to bring the salaries down to their previous level.

—Carl Morey,
Big Rapids, Mich.

Devise an Amortization Plan!

To the Editor:

OUR President's plan for industrial recovery and unemployment relief by recommending a shorter work week with a living wage is a means for quick readjustment of our past and present conditions. However, I believe that there should be included in the plan a system of amortization of new equipment. I have seen many machines which have been in actual service longer than the life of an average man. Why should we expect such machines to return the full amount of cost within one, three or even ten years when they are in good condition and usable for many years more?

A practical solution of this problem would be that the President's Industrial Program consider a schedule for the amortization of all classifications of production machinery including public utilities and power plant equipment based on a fair life expectancy; reasonable allowance provided for repairs and interest on the investment, using the direct amortization method for the full life expectancy and sharing a prorata portion of the profits with labor to provide shorter working hours and increased wages.

To make this plan practical and fair to all industry and all users of labor saving machinery, it should be made compulsory by the Federal Government for the purchaser to set up the cost for each machine or equipment with its life expectancy according to a standard schedule.

Detailed investigation of the financial set-up of such a plan will reveal the opportunity to help improve conditions by having a standard rate of amortization for machinery based on useful production years. I believe that if this plan were adopted and made compulsory for all manufacturers, it would be a means for helping the present readjustment and a great incentive to improving our production by development of new machinery and processes.

—Charles A. Dreisbach,
New Haven, Conn.

Choosing Correct Alloys

To the Editor:

I HAVE just received the *Directory of Iron, Steel and Nonferrous Alloys* which you advised you were sending in your letter of September 15. Please permit us to offer our congratulations upon this compilation. We are frank to say that it will come in very handy to us in many ways and it seems to us that this booklet will prove invaluable to designing engineers. I am wondering if it will be possible for you to favor us with two additional copies. We would be glad indeed to pay for them if you will enclose your invoice.

—J. L. Cawthon Jr.,
Columbus, O.

To the Editor:

PLEASE send addressed to the personal attention of the writer a copy of your *Directory of Iron, Steel and Nonferrous Alloys.* If there is any charge please advise and a check to cover will be forwarded to you.

—H. Von Thaden,
New York

To the Editor:

WE ARE in receipt of one copy of the Third Edition of *Directory of Iron, Steel and Nonferrous Alloys.* It is our desire to secure three more copies of this directory for our Metallurgical and Engineering Departments and we would, therefore, ask that as soon as convenient, they be sent to us. We note the cost of these editions is twenty-five cents each and we would, therefore, ask that you send us your invoice for them at the time they are forwarded.

—M. L. Clavert,
Cedar Falls, Ia.

To the Editor:

THE writer wishes to acknowledge and thank you for the copy of the *Directory of Iron, Steel and Nonferrous Alloys* received today. The information contained in this booklet is of great value to us and I am just wondering if you could spare us six more copies for our engineering, sales and purchasing departments. Your compliance with this request will indeed be appreciated.

—H. L. Martin,
Indianapolis

Editor's Note—The foregoing gives a small cross section of the many letters received by Machine Design ordering extra copies of the directory published as a supplement to the September issue.

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

Standard for Gear Materials and Blanks Approved as Recommended Practice

LISTED among current engineering topics is the announcement that the American Standards association has approved as recommended practice a standard for gear materials and blanks. The new project covers forged and rolled carbon steel, steel castings, bronze and brass castings, and forged and rolled alloy steel. Each of these sections of the standard includes chapters on general specifications, manufacture, ladle and check analysis, finish, marking, inspection, rejection and reheating. Table of chemical composition also are included for each type of material.

The standard was developed by the sectional committee on standardization of gears under the joint sponsorship of the American Gear Manufacturers' association and the American Society of Mechanical Engineers.

* * *

Manual Discusses Problem of Presenting Data in Condensed Form

PRINCIPLES of efficient presentation of data are included in *Manual on Presentation of Data* prepared by a special committee of engineers under the sponsorship of American Society for Testing Materials. The manual discusses the application of statistical methods to the problems of condensing information contained in a set of observations and presenting the essential information in a concise form more readily interpretable than the unorganized mass of original data. Attention is directed particularly to quantitative information on measurable characteristics of materials and manufactured products.

In addition to pointing out the important measures or values which are especially useful for summarizing information contained in a set of observations, the committee has given methods of computation, etc. In a particular instance the functions of the data which should be presented depend upon what uses are to be made of them and accordingly there is a section devoted to essential information. Critical comments on various methods used in presenting data, a discussion of what relevant information should accompany the data and the committee's recommendations for data presentation are included.

The 45-page manual is available through the A. S. T. M. at 1315 Spruce street, Philadelphia, for 50 cents a copy.

* * *

Rail Bus Will Be Able to Maintain Seventy Miles Per Hour

INDICATIONS are that rail transportation will again hold its former place in the public's favor. One company declares that this generation will doubtless see rail busses running at speeds from 60 to 100 miles an hour with schedules even more flexible than present bus transportation. Out in Clintonville, Wis., the Four Wheel Drive Auto Co. has designed a rail bus with deluxe accommodations for 35 passengers. Driven by two 86-horsepower motors, it can attain speeds in excess of 70 miles an hour with safety.

The unit differs from former four-wheel drive applications in that each axle is driven by a separate motor through a three-speed transmission. Wheels of the rubber insert type are employed, the cushioning effect of the rubber dampening rail vibration.

* * *

Machinery and Allied Products Group Gains New Adherents

TWENTY-FIVE additional applications of trade associations for membership in the Machinery and Allied Products institute were approved at a recent meeting of the executive committee. Representative associations already

admitted include: Compressed Air institute, National Machine Tool Builders' association, Refrigerating Machinery association, Oilwell Machinery Manufacturers' association, Locomotive institute, and Mechanical Press Builders' association. M. J. Reed who has been appointed New York representative of the institute, formerly was secretary of the Diesel Engine Manufacturers' association.

* * *

International Congress for Applied Mechanics To Be Held

PLANS are under way for the fourth International Congress for Applied Mechanics to be held at Cambridge, England, July 3 to 9, 1934. An English organizing committee already has been formed. Subjects to be discussed will include: Rational mechanics, mechanics of fluids, materials, and water waves in reference to resistance and stability of ships and seaplanes.

The applied mechanics division of the American Society of Mechanical Engineers is co-operating with the committee with the idea of coordinating the participation of other American groups in this congress.

* * *

Air-Conditioned Automobile Holds Interesting Possibilities

AIR conditioning continues to annex new fields; this time the automobile. According to *Business Week* the idea largely was conceived by John Allston Sargent, Campbell Metal Window Corp. His unit may be slung beneath the floorboards of the car or the heating and cooling coils may be placed behind and under the front seat. Fresh air is taken in through twin ducts underneath the car, filtered, passed through the usual conditioning process and blown into the car. The refrigerating compressor and fans are powered by a generator driven off the engine; heating is done with water from the engine.

* * *

Construction Progresses on Dirigible Being Built in Germany

NEWS comes from Friedrichshafen, Germany, that progress is being made in the construction of the new dirigible LZ-129 at the Zeppelin Works there. The ship is expected to be completed next spring. It will be almost twice the size of the Graf Zeppelin and somewhat larger than the MACON and ill-fated AKRON.

* * *

Packaging Machinery Manufacturers Institute Organized at Recent Meeting

WITH seventy-five per cent of the industry represented, the Packaging Machinery Manufacturers Institute Inc. was completely organized at a meeting held recently in Buffalo. A code of fair competition was prepared and unanimously approved. The meeting also gave the committee appointed by the board of directors full power to act for the industry. H. H. Leonard, vice president and general manager of the Consolidated Packaging Machinery Corp., was elected president of the organization. W. J. Donald is executive vice president and treasurer.

* * *

Pumps Employed to Change Crankcase Oil in Five Minutes Time

NEW developments pertaining to automotive equipment include a five-minute oil changer which is designed to save the motorist's time. With this device it no longer is necessary for the garage or oil station attendant to crawl under the car, remove the plug and let the contents of the crankcase drain by gravity. Electrically driven pumps of the new device draw the oil from the crankcase through the dip-stick hole and discharge it into a glass tank where its condition can be checked. If the oil needs changing the attendant throws a switch, the oil changer then flushing the crankcase. Should a change be found unnecessary, a reversible pump forces the oil back into the engine.

* * *

Science of Spectroscopy Finds Unique Application in Foundry Industry

SPECTROSCOPY is the somewhat formidable term applied to a science which is beginning to find application in the foundry industry through one of the branches, spectrum analysis. By a clever combination of camera, mirrors and prism, a characteristic film is obtained of any desired specimen. By close observation of marks on the film, the skilled operator can determine the relative amount of each of the elements involved.

ASSETS TO A BOOKCASE

Review of Books Pertaining to Design

Theory of Thermionic Vacuum Tubes

By E. Leon Chaffee; published by McGraw-Hill Book Co., New York; available through MACHINE DESIGN *for* $6.00 *plus* 15 *cents postage.*

For accurate application of vacuum tubes the designer must know the fundamentals. This is the particular reason for calling attention to this book that presents only the theory of the operation of these devices which are finding increasing application in industry. Certain sections go into considerable detail and may to advantage be omitted on the first reading, thus for the guidance of the reader these sections are indicated by an asterisk.

The author has endeavored to present the basic principles of the subject, avoiding discussion of the numerous circuits in which vacuum tubes may be used. Because circuits and applications change from year to year although the fundamental theory remains the same, he worked on the premise that with an understanding of the principles any circuit and any application can be analyzed.

□ □ □

Standards and Specifications for Metals and Metal Products

Compiled by the bureau of standards, Washington; available through MACHINE DESIGN *for* $3.00 *plus* 20 *cents postage.*

Engineering department executives are finding in this volume a convenient reference guide to the standards and specifications for metals and metal products prepared by over 80 nationally recognized organizations. The 1359 pages include over 1600 standards and specifications covering both ferrous and nonferrous metals. Methods of testing, chemical analysis, metallic coatings, and heat treatment of metals, etc. are given in considerable detail.

The intimate relationships among the specifications and standards pertaining to various metals and metal products are reflected in this book in the unusual number of cross references. Common ground also is covered by several different organizations producing similar or even identical specifications on the same commodity.

□ □ □

Procedure Handbook of Arc Welding Design and Practice

Published by Lincoln Electric Co., Cleveland; available through MACHINE DESIGN *for* $1.50 *plus* 15 *cents postage.*

This book sets a new mark in arc welding literature, covering both design and procedure. Encyclopedic in contents, it is divided into eight principal parts. Each deals with an important phase of arc welding and contains detailed drawings and photographs to illustrate the text.

Subjects treated include various welding processes, definitions of welding terms, classifications of welds, strength of welded joints, methods of relieving stress, specifications for steels and alloys of good weldability, etc. The foregoing is indicative of its value to designers to whom the section on construction details of basic machine parts built by welding will appeal strongly.

□ □ □

Standards Yearbook, 1933

Compiled by bureau of standards, Washington; available through MACHINE DESIGN *for* $1.00 *plus* 15 *cents postage.*

The current volume is the seventh edition of this standardization annual and is replete with suggestions and data for those interested in this phase of activity. In it are outlined the activities of not only the bureaus and agencies of the federal government, but also those of states and counties. In addition, a resume is given of the standardization work of scientific and technical societies and trade associations. A brief account of international co-operation in standardization is followed by a summary of the activities of the national standards associations of various countries.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

WHEN announcement was made recently that a contract for the second largest telescope in the world had been awarded, the attention of the engineering profession immediately was drawn to E. P. Burrell. As director of engineering, Warner & Swasey Co., Cleveland, by which organization the astronomical unit will be built, he will be responsible for the layouts and design. The instrument is to be completed in 1935 for the new McDonald observatory to be erected on Mt. Locke in Southwestern Texas.

Strange as it may seem, Mr. Burrell also is a designer of machine tools. This versatile engineer was born at Hall, New York, in 1871. After attending Cornell university from 1894 to 1899 he was graduated with the degree of master of mechanical engineering. Subsequently he was employed by Crehore-Squire Transmission Co. When that organization was dissolved in 1900 he joined the Warner & Swasey company as draftsman. Later he became plant engineer, then works manager and in 1924 was appointed to his present position.

ACTIVITIES of the mechanical research section of the General Electric research laboratories now are under the direction of E. L. Thearle. He succeeds A. L. Kimball who has been transferred to assist all design engineering departments of the company on problems involving ventilation, vibration and noise, co-operating closely with the laboratories. A picture and biographical sketch of Mr. Kimball appeared in the Feb., 1931, issue.

Mr. Thearle was graduated from Cornell university in 1921 with the degree of mechanical engineer. He remained there through 1925 as an instructor in the mechanical engineering department. For the following three years he was in charge of the mechanical engineering department at the University of Arkansas. Since 1928 he has been in the mechanical research section of the G. E. research laboratory.

His work on dynamic balancing, including the design of a new balancing machine (M.D. July, 1931) for the rapid and accurate balancing of small rotors has won acclaim throughout the engineering profession. This unit embodies a method for obtaining in three runs an exact balancing of rotors in their own bearings.

ONE of the nominees for vice president of the American Society of Mechanical Engineers is William L. Batt, president of SKF Industries Inc., New York. A member of the society since 1911, he has been actively interested in its work, serving as chairman of numerous committees. At present Mr. Batt is a manager of the society.

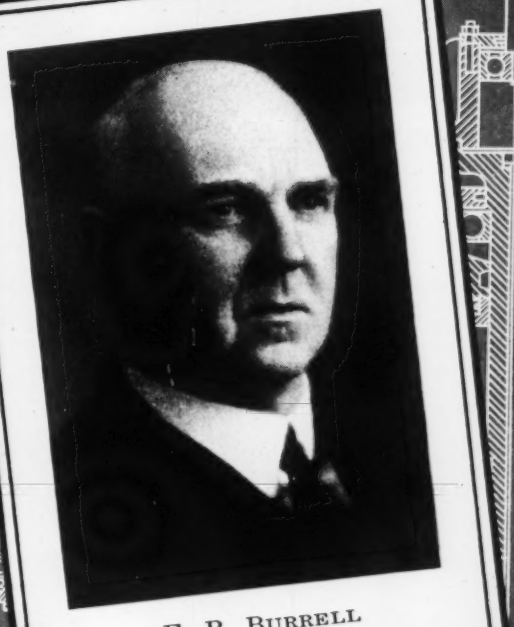
Salem, Ind. in 1885 was the place and date of his birth. Later his family moved to Lafayete, Ind., where he attended public school and subsequently Purdue university. In 1907 he was graduated with a degree in mechanical engineering. Shortly thereafter he became associated with the Hess-Bright Mfg. Co., Philadelphia, in manufacturing, engineering and sales of antifriction bearings.

Mr. Batt was appointed general manager of the company in 1917 and following the consolidation of SKF Ball Bearing Co., Hess-Bright Mfg. Co. and other units, he was made vice president of SKF Industries Inc., the central organization. Since 1922 he has held the office of president.

For his interest and activity in promoting commercial relations with Sweden, King Gustav V in 1926 conferred upon him the decoration of the Order of Vada.

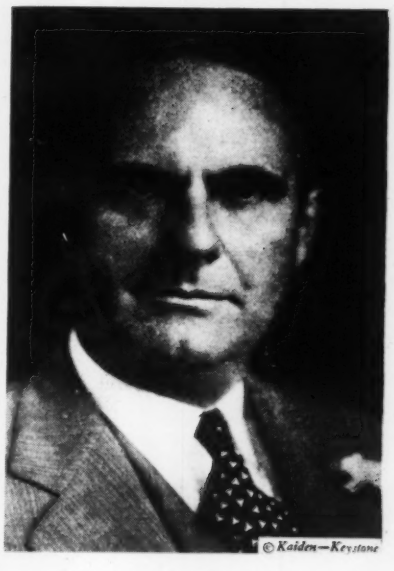
PROMINENT among engineers interested in reversed refrigeration cycle (M. D., page, 26, April, 1932) is Harold L. Doolittle, chief designing engineer, Southern California Edison Co. Ltd., Los Angeles. In a statement late last year he declared that the installation in the building

Leaders in Design, Engineering and Research

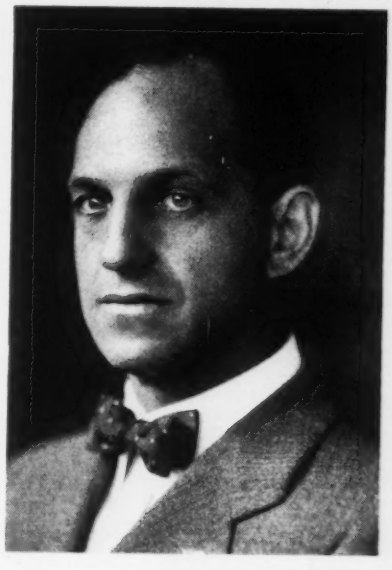


E. P. BURRELL

E. L. THEARLE



WILLIAM L. BATT



H. L. DOOLITTLE

occupied by his company was not only practical but also economical.

Recently Mr. Doolittle was nominated as a vice president of the American Society of Mechanical Engineers for 1934. In 1930 he was elected a manager of that organization, his term expiring this year. After enrolling as a junior member in 1910, he advanced to full membership in 1916 and was chairman of the Los Angeles section in 1921.

Mr. Doolittle gained his academic training in engineering at Cornell university from which he was graduated in 1906 with the degree of mechanical engineer. Spending three years in miscellaneous design work in Los Angeles, he entered the employ of the Edison company as draftsman and designer. He was assistant construction engineer for 14 years and has held his present position for the past seven years.

* * *

P. J. Flaherty, president of Johnson Bronze Co., New Castle, Pa., has been made president and chairman of the executive committee of the Cast Bronze Bushing institute.

* * *

F. F. Brand recently was appointed assistant to the manager in charge of engineering, Pittsfield Works, General Electric Co.

* * *

Oliver E. Buckley succeeds the late Dr. H. D. Arnold as director of research for Bell Laboratories Inc., New York.

* * *

Fred R. Erbach, chief engineer, General Refrigeration Co., Beloit, Wis., recently was appointed vice president and general manager.

* * *

Carl G. Ohlson has joined the staff of the Aetna-Standard Engineering Co., Youngstown, O., in the capacity of vice president in charge of engineering.

* * *

H. B. Vollrath, for 14 years sales engineer for Baker Perkins Co., has resigned to accept a position on the engineering staff of Sylvania Industrial Corp., Fredericksburg, Va.

* * *

Robert P. Lamont recently resigned as president of the American Iron and Steel institute. Charles M. Schwab, who became chairman of the organization when Mr. Lamont was made president, will act nominally as president.

* * *

Joseph L. Greene, formerly connected with the John Deere Spreader Works of Deere & Co. in the capacity of draftsman and experimental engineer, recently has become associated with the LaCrosse Plow Works of Allis-Chalmers Mfg. Co. in experimental and design work on farm machinery.

* * *

B. S. Hopkins was elected president of the Illinois Academy of Science at the recent annual meeting in East St. Louis.

* * *

Harry J. Buncke has joined the Oxford Paper Co. as chief engineer of the Rumford, Me., plant. F. J. Latham, formerly chief engineer, will serve the company as consulting engineer.

* * *

H. W. How has joined the staff of the process equipment department of Blaw-Knox Co., Pittsburgh. He will become actively associated with the further development of welded pressure equipment.

* * *

William T. Conlon now is manager of the industrial department of the Superheater Co., New York. In this capacity he will have charge of design, manufacture and sale of superheaters and other types of equipment.

* * *

E. M. Clark has retired as director and vice president of the Standard Oil Co. of New Jersey. He was associated with Dr. William M. Burton in the development of the first successful cracking process.

* * *

C. B. Veal, assistant general manager, Society of Automotive Engineers, and H. E. Newell, National Board of Fire Underwriters, have been reappointed to membership on the American Standards association board of examination for the next two years.

* * *

Harry S. Rogers, since 1927 dean of engineering, Oregon State college, Corvallis, has resigned to become president of the Brooklyn Polytechnic institute, Brooklyn, N. Y.

* * *

J. Ralph Patterson recently was appointed general manager of sales of Mackintosh-Hemphill Co., Pittsburgh. He has had 20 years of experience, beginning in 1913 with erection of steel mills and transferring his attention to the manufacture of mill equipment for the past eleven years with the company.

NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

EMPLOYING a number of individual nozzle sets, each of which includes one or more nozzles designed to operate a turbine at a particular speed with maximum efficiency, Oliver D. H. Bentley recently was granted a patent on his elastic fluid turbine, Fig. 1. He states in his

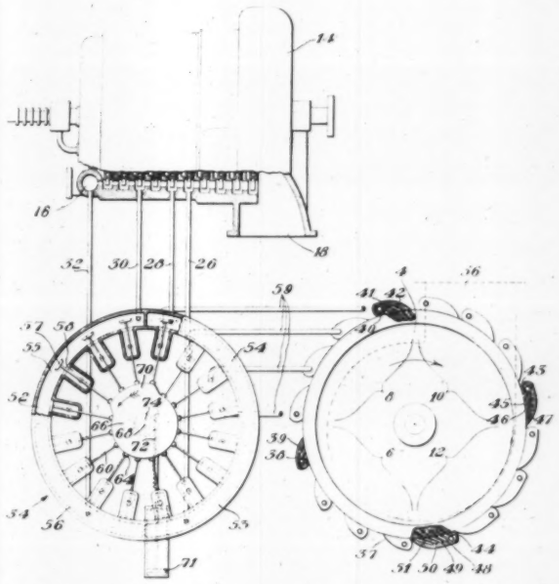


Fig. 1—Each group of nozzles of turbine is designed to operate the unit at different speeds

patent that the common method of controlling power of a turbine consists in adding or cutting out one or more nozzles. Such a method is claimed to be reasonably satisfactory for a constant speed load but is open to disadvantage of considerable loss in efficiency when the load is such as to require operation of the turbine at different speeds.

In this unit every nozzle set in the auxiliary turbine 4 comprises four nozzle heads or units 37, each having a nozzle and one or more reversing buckets. Set 6 which is designed for the lowest speed, comprises units each having a small nozzle 38 and reversing bucket 39. Nozzle set 8 likewise comprises four nozzles 40, but with higher expansion ratio. Similarly sets 10 and 12 have increasing expansion ratios. Valve mechanism 34 for supplying the steam to the different nozzle sets, embodies a fluid distributor divided into four separate chambers, 53, 54, 55 and 56. Each valve has a stem 60 passing through the depending valve chamber 58. On the bottom of each valve is a cam follower 64 engaged by cam 66 on shaft 68 concentric with distributor 52. The cam has a high part 70, sufficient in size to keep four valves lifted at all times. The remaining twelve valves are maintained closed by springs.

For intermediate speeds, one or more of the valves in the separate chambers can be closed. with corresponding opening of the valve in the next higher or lower pressure chamber, incurring only slight loss of efficiency at these speeds. The cam may be operated manually but preferably is controlled by any of the usual form of apparatus of this type employed for automatic draft control in power plants.

B. F. Sturtevant Co., Hyde Park, Mass., is assigned the patent designated No. 1,922,074.

AN ELECTRIC governor which may be associated with the timer mechanism has been designed by Merlin A. Sticelber to provide a means for controlling an internal combustion engine. On the inner surface of housing ring 26, Fig. 2, are two conductor half-rings 47 to 48 insulated from each other. Spring brushes 51 and 52 oppositely secured on governor ring 43 are designed to contact members 47 and 48 when centrifugal force has moved the governor ring to a horizontal position.

When the timer shaft rotates at a speed that

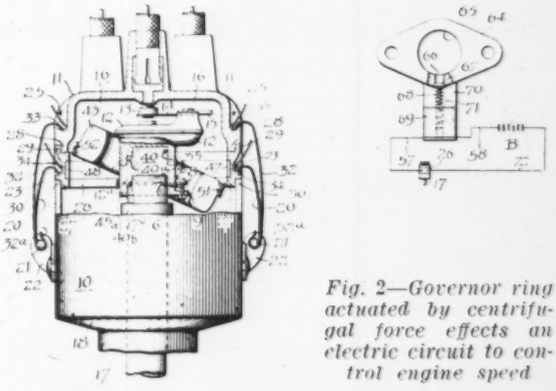


Fig. 2—Governor ring actuated by centrifugal force effects an electric circuit to control engine speed

denotes a predetermined engine or vehicle speed, the governor device completes a circuit through the contact half-rings. Thereupon the solenoid coil 69 shown in the drawing at right of Fig. 2, is energized to retract valve 67 against tension of spring 71. This controls the fuel mixture from the carburetor to the engine cylinders, and slows down the engine. The engine may not therefore, drive the vehicle at a rate higher than the predetermined one. Adjustment at 6, 7, 8 and 9 (left, Fig. 2) determines the speed at which the governor becomes effective.

The patent, No. 1,919,536, is assigned to the Nafziger Corp., Kansas City.

HINGED segments connected by a toggle mechanism permit a newly patented reel as commonly used for sheet coiling to be collapsed in such a manner that all of its diametral dimensions are reduced. It was this feature that some of the prior art reels lacked, according to the inventor Kurt P. Kohler. The drawing at *A* Fig. 3, shows details of the reel in section, while the view at *B* depicts the unit in collapsed position. As illustrated, the carrying surface of the reel comprises a fixed segmental member 1 supported by spokes or arms 2 on a hub or spider 3.

The toggle mechanism comprises two links 17 and 18 hinged to the free ends of the movable carrying plates 11 and 12, respectively, by means of hinged joints similar to those which connect the movable carrying plates to the fixed segments 1. Adjacent edges of links 17 and 18 are provided with alternate interlocking projections 19 having hinged bosses 20 for receiving pivot pin 21.

For operating the toggles 16, cam plates 31 and 32 are provided at each end of the reel. When cam plates 31 and 32 are turned, *C*, Fig. 3, relative to toggle pin 21, the pin will be caused to move inwardly along the radial line defined by guide slots 27 to the position shown at *B*, wherein the toggle joint is broken and the reel collapsed for removing coiled material. United Engineering & Foundry Co., Pittsburgh, is assignee of the patent which is designated No. 1,905,178.

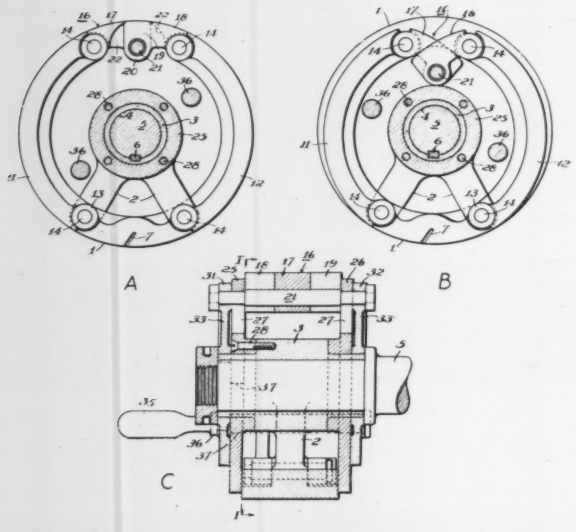


Fig. 3—Collapsible reel embodies toggle mechanism which reduces diametral dimensions

A PATENT covering a fastening device, Fig. 4, recently was granted to Stephen Paul for Paul Threadless Bolt Co., Lansing, Mich. As shown by the drawing, there is provided on a bolt tapered surface 16, inclining inwardly at a slight angle. A split sleeve 18 or similar wedging means having a tapered interior surface corresponding to the taper on the bolt, is mounted over this tapered portion. Sleeve 18 is provided with an exterior surface tapered in the opposite direction to that of its interior surface. Collar 22, having an interior surface with a taper corresponding to the exterior taper of the split sleeve then is forced over the sleeve to retain the parts in position. No. 1,913,408 identifies the patent.

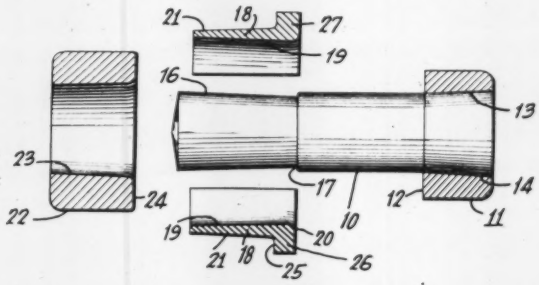


Fig. 4—Fastening device or threadless bolt in which tapers retain parts in position by friction

Review of Noteworthy Patents

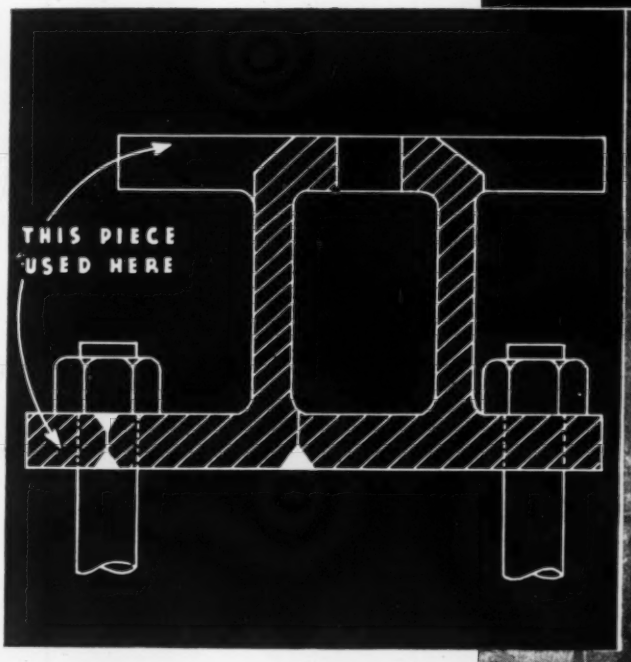
Other patents pertaining to design are described briefly as follows:

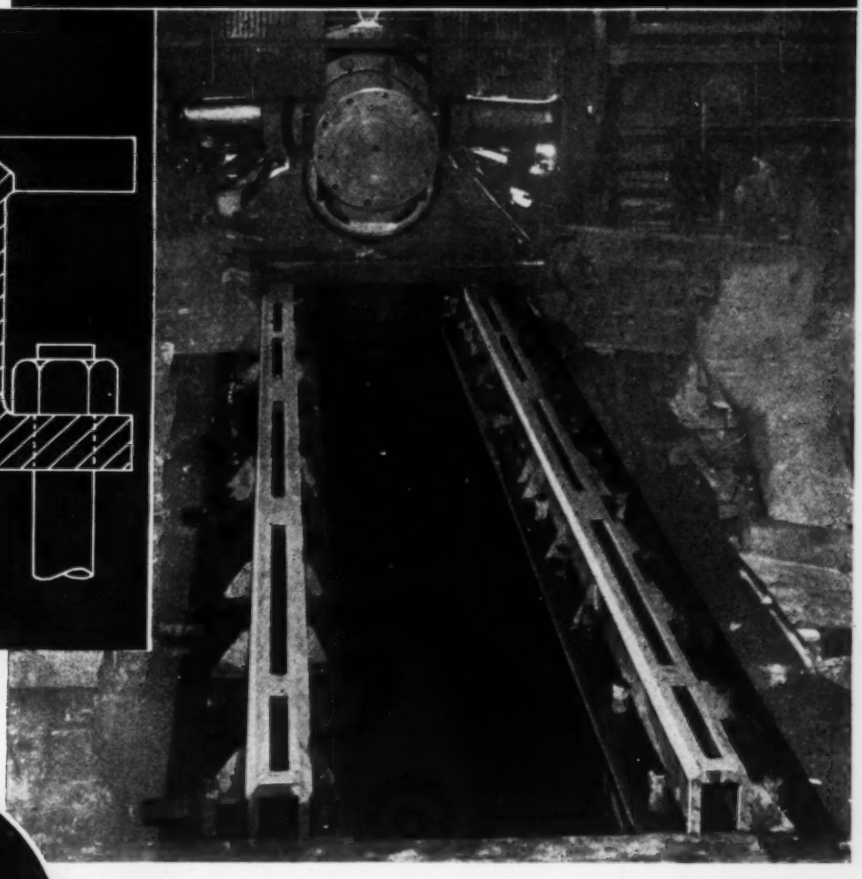
KNITTING MACHINE. 1,927,016. In the knitting machine covered by this patent there is the combination of a circular bank of stitch-forming elements, a yarn guide, a pattern-controling element and other mechanisms. Assigned to Jacquard Knitting Machine Co. Inc., New York.

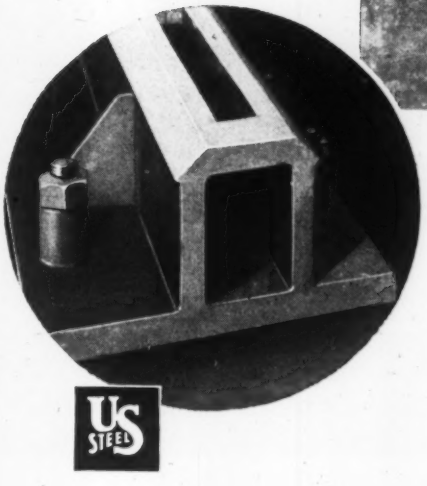
BRUSH MOUNTING. 1,927,176. Details embody a small commutator motor having brushes, means acting when the motor is running to shift the brushes slightly and repeatedly to change the angle of presentation to the commutator. Assigned to Thomas A. Edison Inc., West Orange, N. J.

BUTTER WRAPPING MACHINE. 1,927,011. This patent covers the combination of a folding mechanism comprising side members for folding the wrapper against the sides of the print, and tuckers to fold the wrapper against the ends, etc. Assigned to Cherry-Burrell Corp., Cedar Radips, Iowa.

E TAKE OUR OWN MEDICINE *and like it!*







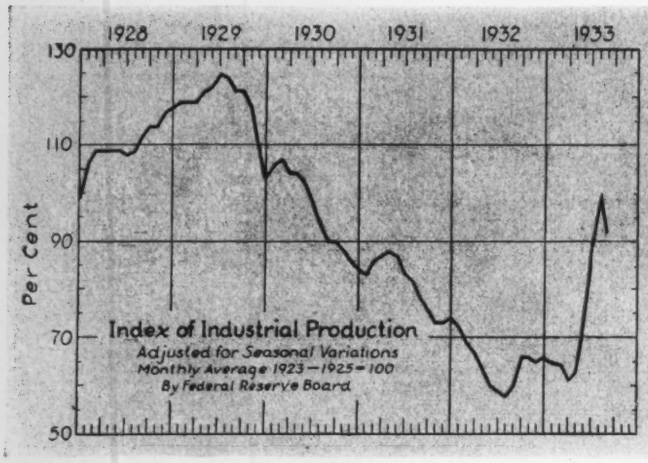
For some time we have been advocating the use of rolled steel in machine construction. Consequently, when it recently became necessary to replace the cast iron shoes upon which ride the roll housings of one of the 22″ mills at our Clairton Works, we followed our own advice. The shoes were redesigned and built at the plant, employing the welded construction of CB Sections. Their cost, figuring the steel of our own make at present market prices, showed a savings of 32.2% over the estimated cost of cast iron shoes. No patterns were necessary. The construction time was materially shortened. The strength of the shoes was greatly increased. This one case is typical of many others in our own experience. Investigate this important source of product improvement and cost reduction. We are ready to cooperate with you.

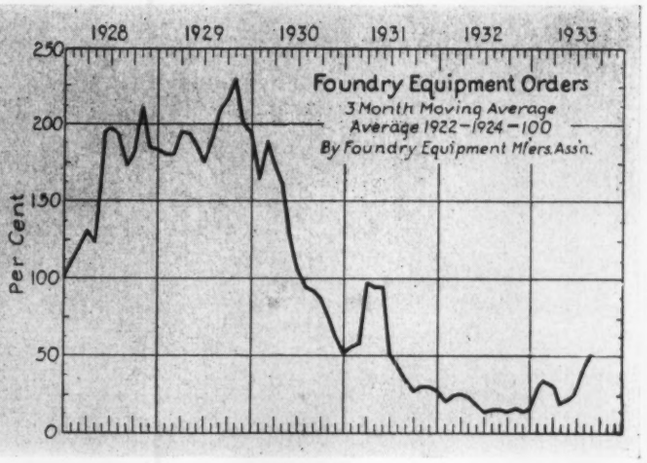
CARNEGIE STEEL COMPANY

SUBSIDIARY OF UNITED STATES STEEL CORPORATION

PITTSBURGH • PENNSYLVANIA

226



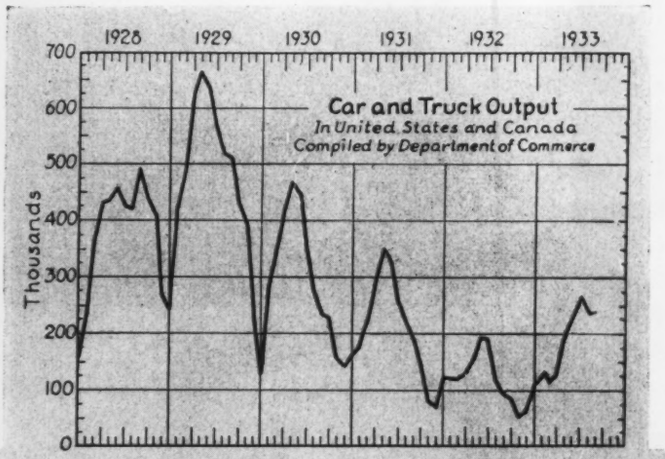


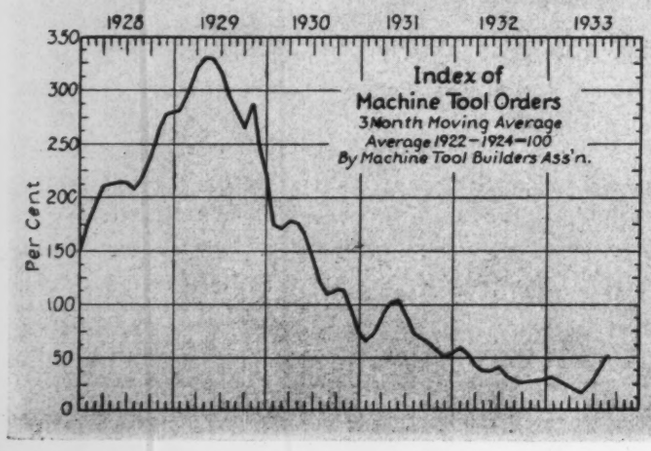
How Is Business?

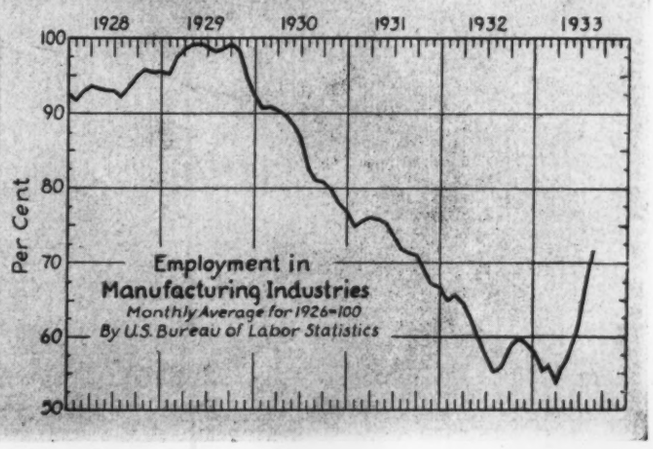
LIKE an army preparing for a major offensive, business has been drawing its lines tighter, preparing its marching orders by completing major NRA codes, and getting set to push off toward continued improvement this fall and winter.

The codes have done a great deal to delay, or rather slow up, the improvement at this time. No wise leader pushes ahead until he knows where he is going. Now, however, uncertainty has been materially reduced. The road is well marked and it is up to the business leader to follow it. Success begets success. The less anemic pay envelopes of the past few weeks are certain to result in more orders, more industrial activity and still higher pay.

That business has not been completely static even though the rate of increase had declined appreciably is evidenced by the fact that the middle of September witnessed the highest output of electricity registered this year. This peak was the greatest of four peak weekly productions attained in 1933. It shows a gain of 12.7 per cent over production of a year ago compared with the preceding week's gain of 11.1 per cent. Manufacturing production is another evidence of this trend. The first seven months of 1933 were 16 per cent higher than all of 1932.







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Century

10 Horse Power Century Totally Enclosed Fan Cooled Squirrel Cage Induction 3 Phase Motor

TOTALLY ENCLOSED FAN COOLED MOTOR

Wherever there's dust or dirt . . . . dampness or moisture . . . . or atmospheric conditions that would harm an ordinary motor—the best assurance of continuous and satisfactory operation is a Century Totally Enclosed Fan Cooled Motor.

It is built with a protective, enclosing cast-iron "shell" and a fan that draws objectionable vapors or matter through the motor without allowing it to come in contact with the windings or rotor . . . . Steam and vapor cannot enter the motor closure . . . . Dust, powder or floating particles that may "pack," or are abrasive, cannot sift into the motor.

Built, when required, in explosion resisting frames to operate in explosive atmospheres. Sizes 2 to 150 horse power—for single, two, three or four speeds and to operate by push button, float switch, pressure, manual, automatic or position control.

See Century Electric Company Display, Electrical Building, Century of Progress.

SPLASH PROOF

Century Splash Proof construction protects the motor against splashing water when the plant and machinery is washed down.

CENTURY ELECTRIC COMPANY

1806 Pine Street , , , St. Louis, Mo.

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ALTERNATING AND DIRECT CURRENT, SINGLE PHASE, POLYPHASE, SPLIT PHASE, MULTI-SPEED AND SPECIAL MOTORS, RANGING IN SIZE—DEPENDING ON TYPE—FROM 1/250 TO 600 HORSE POWER . . . GENERATORS, MOTOR GENERATOR SETS, ROTARY CONVERTERS.

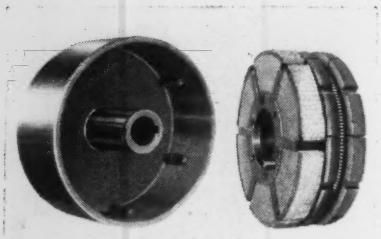
NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Safety Coupling Releases Load

INSTANTANEOUS release of power input from the driven machine in case of accidental jamming or other undue overloading is provided by the new safety drive coupling produced by Zobell Electric Motor Corp., Garwood, N. J. This device, shown herewith, is fully automatic and can be used with all types of drives.

The coupling comprises two sections, the starting section and the service section, each of which consists of a ring of segments and operates through the action of centrifugal force. During the starting period the starting section is the load carrying member, but as a predetermined speed is reached centrifugal force overcomes the force of the spring holding the segments of the starting section in contact and disengages this portion of the coupling. At this speed centrifugal force brings the service section into contact and this section carries the load during running.



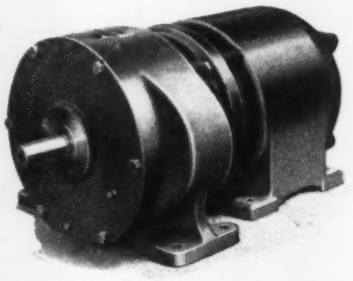
Any slowing down or jamming of the driven machine will lessen centrifugal force and disconnect the coupling

As the power transmitted is dependent on centrifugal force, any slowing down or jamming of the driven machine deprives the service section of its holding power, thus cutting off all connection between the driven and driving machines.

Motorized Reducer Units Announced

A NEW and complete line of motor reducers with standard reduction ratios of from 3:1 to 600:1 have been brought out by Davis & Thompson Co., 6619 W. Mitchell street, Milwaukee. This line of planigressive reducers, one of which is shown herewith, is designed to use a standard NEMA motor without change. The motor shaft is not turned down.

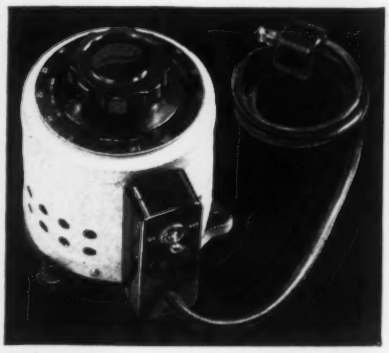
The type A reducer is made in ratios from 3:1 to 7:1, reduction being obtained through planetary gears. Reduction is obtained in the type B reducer by the use of compound helical gears in ratios from 8:1 to 24:1. Type C increasers are made also in this style. Increasers, used wherever an increase in speed over the speed of the prime mover is required, are available in ratios from 1:1.1 to 1:5. The high speed reduction unit, type D, has ratios from 25:1 to 600:1 as standard.



Compound helical gears are used to obtain speed reduction in this type of planigressive reducer

Transformer Controls Voltage

ALTERNATING current voltage control and a continuous voltage adjustment between 0 and 130 volts when operated from a 115-volt, 60-cycle line is provided by the Variac power transformer brought out by General Radio Co., Cambridge, Mass. The turning of a single knob



Turning of a single knob on instrument for alternating current voltage control covers the entire range of adjustment

SOUND ENGINEERING

Beats "Trick" Sales Appeals

MACHINE performance at lowest cost is a job for the Engineer. Performance features, based on *sound* engineering, outlive a thousand trick sales appeal specifications demanded through the false "ballyhoo" of easier selling.

Today, countless machines throughout industry are burdening costs and stealing profits because "ballyhoo" dictated costly bearing specifications.

No one type bearing serves all applications best. SOUND ENGINEERING, based on equipment and maintenance costs, must dictate the choice.

In countless applications specified by SOUND ENGINEERING practice, performance proves that Johnson Bronze sleeve type bearings give greater economy and efficiency than more expensive type bearings.

Johnson Bronze service provides 22 alloys to meet specific bearing conditions—thousands of designs for specific requirements including graphited bearings for difficult locations and service where lubrication is often neglected.

Eliminate the waste caused by bearing *MISAPPLICATION*. Consult with Johnson Bronze on any bearing problem.

Free Engineering Handbook

This new handy reference book—available November 1st—includes detail information on bearing metals, designs and engineering data. Reserve your copy, now.

JOHNSON BRONZE

BUSHINGS & BEARINGS

Factory and General Offices
New Castle, Pa.

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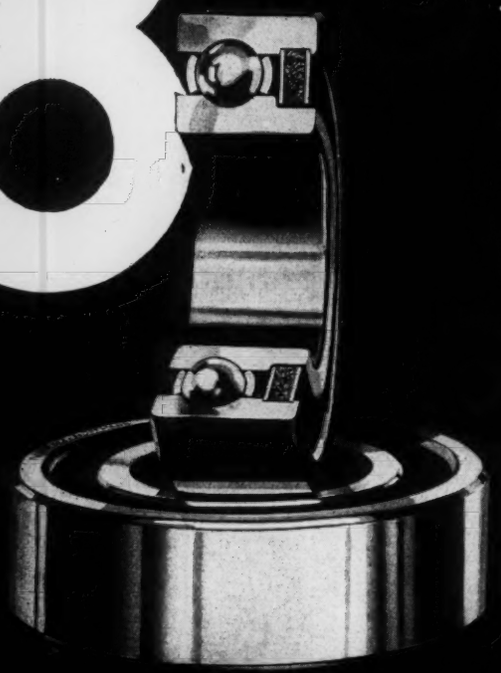
PRODUCTS OF JOHNSON BRONZE: Plain Cast Bronze Bushings . . . Cast Bronze Graphited Bushings . . . Bronze Backed Babbitt Lined Bearings . . . Locomotive and Mill Bronzes . . . Solid and Cored Bronze Bars . . . Plain Sheet Bronze Bushings . . . Sheet Bronze Graphited Bushings . . . Steel Backed Babbitt Lined Bearings . . . Car Brasses . . . Miscellaneous Bronze & Brass Castings

8 POINTS OF SUPERIORITY



①Thick, closely-fitting felts, providing extra protection.

②Effective labyrinth, formed by felt seal and plates against recessed inner ring.

③Seal removable in its entirety—for inspection, cleaning, or renewal of felt if needed.

④Felt seal within confines of inner and outer rings and therefore not exposed to injury.

⑤Wide, solid inner and outer rings, with maximum contact on shaft and housing, make inserts in housing unnecessary and militate against slippage, looseness, and escape of lubricant past outer ring.

⑥Outer ring can be clamped on both faces.

⑦A self-contained all-steel unit; construction assuring dimensional exactness and quiet running.

⑧Grease capacity ample for long periods of service.

Write for the Catalog, describing this 7000 Series "GreaSeal" Bearing, together with the complementary line of adjusting springs, felts and washers.

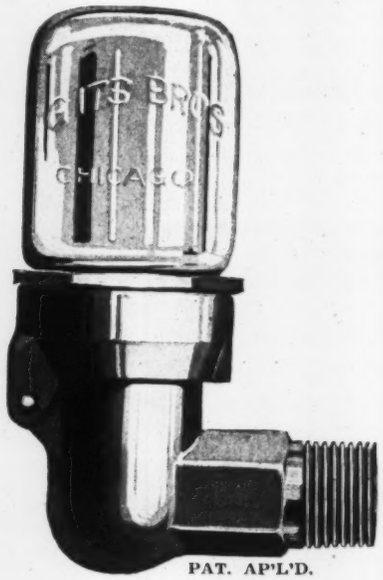
"GREASEAL"
FELT—PROTECTED
‹PATENTED›

NORMA-HOFFMANN BEARINGS CORPORATION, STAMFORD, CONN., U. S. A.

covers the entire range of adjustment. The unit, shown herewith, is made in two models, one with a protecting case intended for laboratory and experimental use, and the other without the case designed for building into other equipment. Maximum current rating for the unit is 5 amperes.

Oilers Permit Visual Inspection

BOTTLE oilers of the constant level type for motors, lineshafts and oil reservoirs have been introduced in a new line by Gits Bros. Mfg. Co., 1846 Kilborn avenue, Chicago. In the oilers, shown herewith, the body and shank are constructed of a one-piece brass forging. A special



Oil level in new line of bottle oilers can be observed at any time through the glass cover

cover which is hinged to the body holds the glass reservoir through which the oil level can be observed at any time. This reservoir or bottle is held securely in the cover with a compression nut and cork packing. No glue or cement is used.

In the hinge type oilers it is not necessary to remove the bottle to refill. The bottle is merely swung around a self-closing spring hinge and the lubricant fed into it through a tube in the cap.

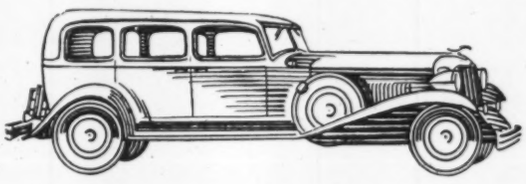
Fewer Parts Used In Improved Pumps

SPRINGS, gears and pins have been avoided in the series of rotary compressor vacuum pumps developed by Gast Mfg. Corp., Bridgman, Mich., resulting in a compact unit with fewer working parts. The pumps are forced air cooled. Fans mounted on the pump shafts plus reduced internal friction combat any tendency to overheat.

The series develops air pressures from one to 25 pounds or vacuum from one to 26 inches con-

YOUR PRODUCT must be lighter?

Call upon Electromet Service



■ If your product must be made lighter without a sacrifice of strength, one solution is to replace ordinary steel with alloy steel parts. Before you write your specifications, however, supplement your knowledge of alloy steels with the vast fund of practical information that Electromet Service offers you without charge. As the pioneer producer of ferro-alloys and metals for steel-makers, Electromet has accumulated a body of data which, applied to your problems, will insure utmost economy in design and maximum satisfaction in performance. To realize maximum return on your investment in alloy steels, utilize Electromet Service. A request on your letterhead will bring you complete information.

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Unit of Union Carbide and Carbon Corporation

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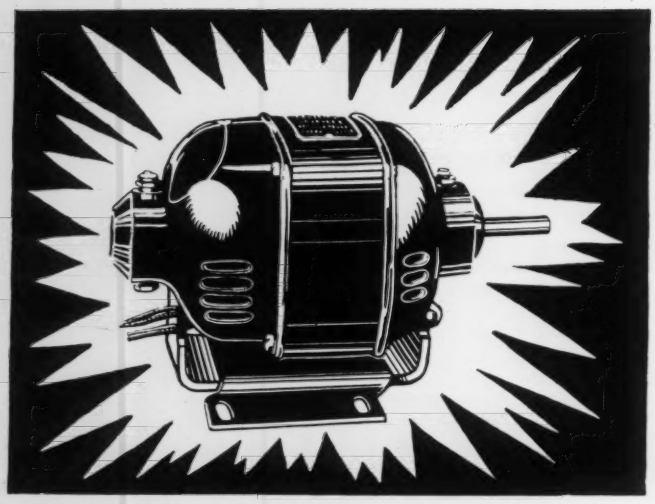


PYGMALION

Leland designers are never wedded to old ideas. Unlike Pygmalion of old, who carved an ivory statue and promptly fell in love with it, they are always ready to improve the product whenever possible.

Leland motors carry the latest features known to the motor designing art. They are sturdy, cool-running and quiet.

Among recent developments on the Leland line are the following:

Geared head motors

Fan cooled fractional horsepower motors

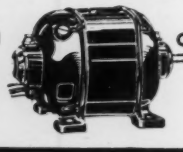
Totally inclosed resilient motors for stokers

Other Leland designs include: cradle base motors for oil burners, stokers, refrigerators, air conditioners and washing machine drives; totally enclosed explosion-resisting motors for use in explosive atmospheres; split phase motors; reversible motors; generators and motor-generator sets, etc.

Advise us of your requirement. There is a Leland to meet it.

THE LELAND ELECTRIC CO.
DAYTON · OHIO · U·S·A

CANADIAN ADDRESS TORONTO



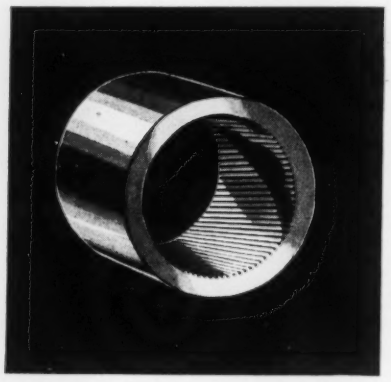
CABLE ADDRESS LELECT

Leland Motors

tinuous duty and up to 35 pounds air pressure during intermittent duty. Either vacuum or pressure service may be obtained with the same pump, or both may be secured when necessary for special work. Provision has been made for direct connection of the pumps to motors from 1200 to 1750 revolutions per minute.

Announces New Graphited Bushings

MORE than 40 per cent of the entire bearing surface of the new graphited bushings being manufactured by Johnson Bronze Co., New Castle, Pa., provides graphite contact with the shaft. The graphite lubricant is dovetailed into the bronze metal structure, as shown herewith, and is not soluble in water, oil or gasoline. If



Graphite lubricant is dovetailed into the bronze metal structure in recently introduced bushings

oil or grease is applied, it penetrates the graphite lubricant and aids in the efficiency of the bearing. Minutely spaced alternating metallic and graphited surfaces produce a structure similar to that found in preferred bearing alloys.

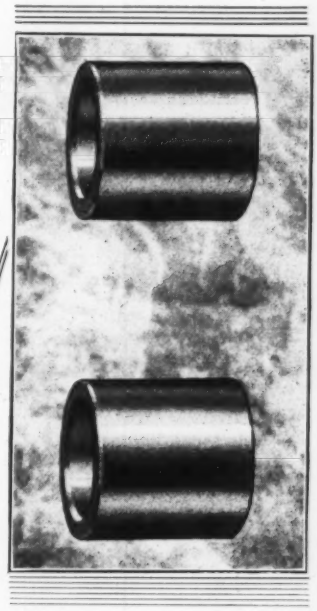
For intermittent action and on less important bearing applications, the company recommends sheet bronze graphited bushings. For high speeds and light loads, or for low speeds and heavy loads, cast bronze graphited bushings are best.

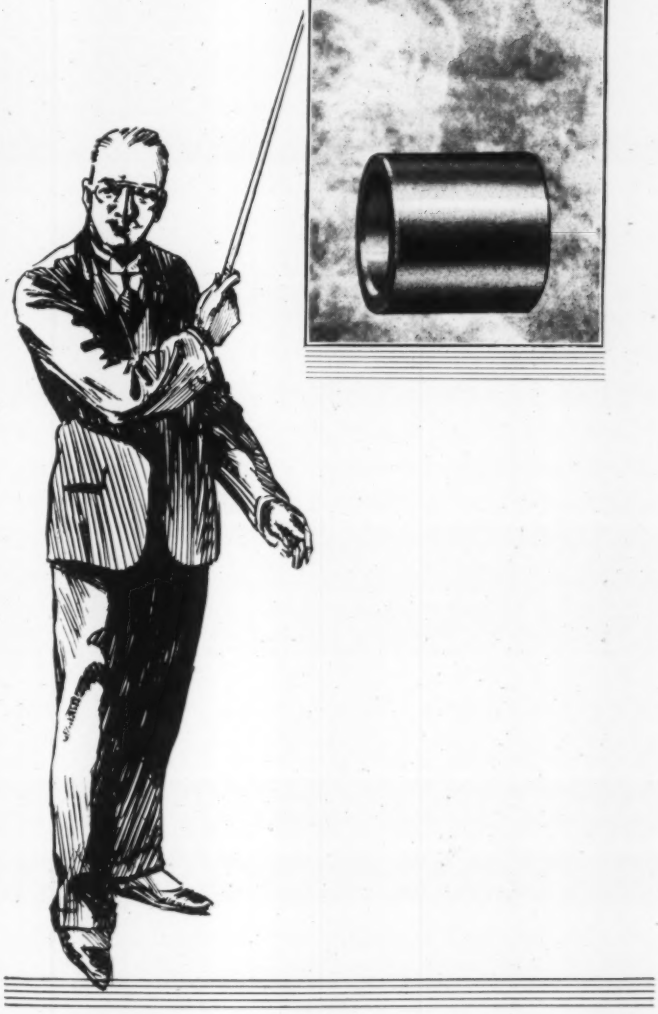
Clutches Are of the Safety Type

SAFETY type magnetic clutches, built along the principle heretofore extensively used only in magnetic brakes, are being manufactured by Magnetic Mfg. Co., Milwaukee. This style of clutch operates in the reverse manner to the standard type of magnetic clutch in that it is mechanically closed by means of powerful springs and opened magnetically in opposition to the same, whereas on the standard line the closing is accomplished magnetically and the opening by mechanical means.

This clutch is particularly suitable where continuous engagement is required and the clutch disengaged only at infrequent intervals. A

Folks—





. . . here are two rollers from one link of a Baldwin-Duckworth roller chain. Their high quality is the result of many years' engineering experience and research.

The same careful attention is given to the selection of materials for these rollers as is exercised in every other part of our chains. Starting with the best materials obtainable, every roller is machined and formed to precision accuracy and subjected to many inspection and gauging operations.

Note the beveled edges which promote free rotation of the roller without danger of binding.

The final heat treatment, accomplished by highly trained experts in this field, renders the rollers exceptionally strong and tough, insuring 100% efficient operation throughout a long and arduous life.

It is this minute attention to every detail that is responsible for the Baldwin-Duckworth enviable reputation as makers of

DEPENDABLE DRIVES FOR EVERY PURPOSE

BALDWIN-DUCKWORTH CHAIN CORP.

SPRINGFIELD, MASSACHUSETTS

FACTORIES AT SPRINGFIELD AND WORCESTER, MASSACHUSETTS

ALLEN

TRI-MARKT

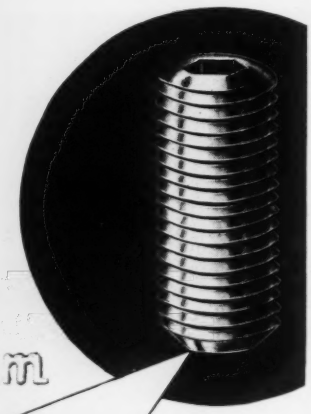
TRADE MARK

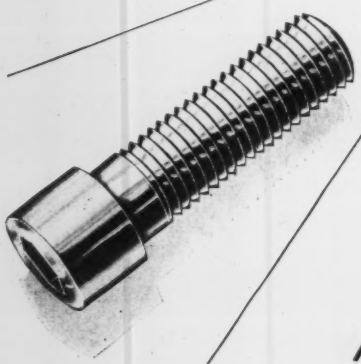
HOLLOW SCREWS

of

Chrome-

Mo-lyb-den-um





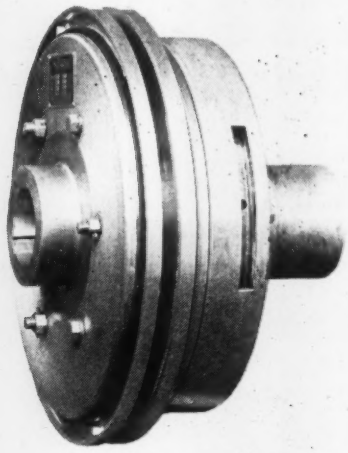
Whether economic changes favor buyer or seller, ALLEN will favor *ITS CUSTOMERS*

Impending changes in sellers' terms place a premium on business connections assuring the buyer a fair deal in addition to the New Deal. You will take a thankful satisfaction in dealing with a source of supply as considerate of your interests as of its own. Allen has not, and will not, take advantage of its customers needs, regardless of its positional advantages in periods of rising prices or seller's market. « « « «

THE ALLEN MFG. COMPANY

HARTFORD, CONN. U. S. A.

comparatively small magnet can be used with intermittent duty coil developing high pressures for disengagement, while the spring or mechanical closing feature permits continuous operation without electrical connection or cost. The clutch, shown herewith, may be built in the single as well as multiple disk construction.

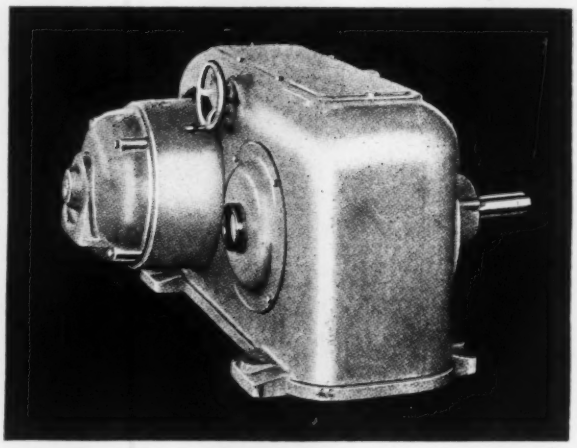


Magnetic clutch is mechanically closed by springs and is opened magnetically in opposition to them

---

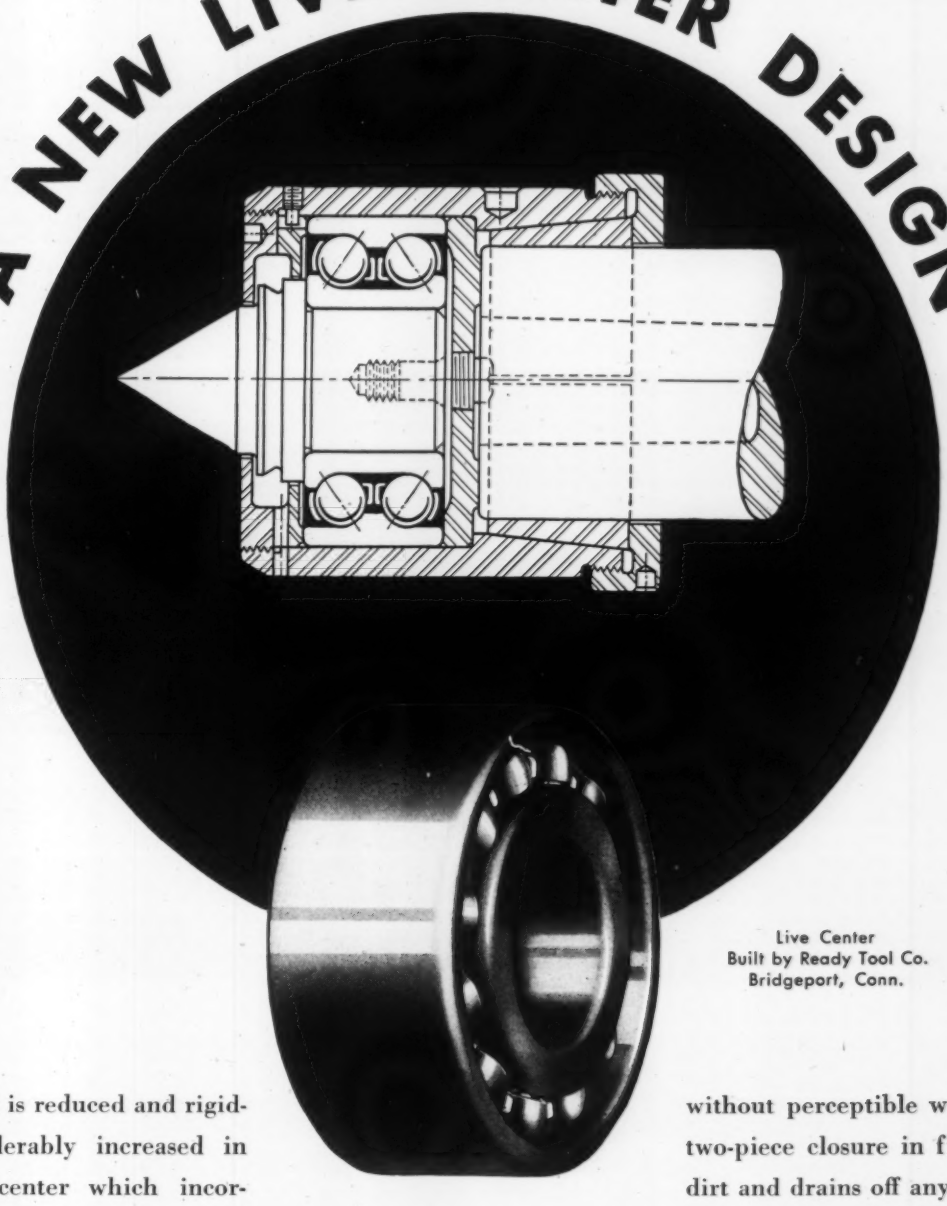
Infinite Speed Variation Is Provided

THE completely enclosed vari-speed motors recently introduced by Sterling Electric Motors Inc., Los Angeles, provide speed reductions which can be varied by infinite degrees through the capacity of the unit. The operating principle of the unit, shown herewith, consists of a wide high speed V-belt running on two V-pulleys which are mounted on fixed parallel spline shafts. Turning of a small handwheel simultaneously changes the diameters of both



Speed reduction can be varied by infinite degrees through the capacity of the unit

A NEW LIVE CENTER DESIGN



Live Center
Built by Ready Tool Co.
Bridgeport, Conn.

OVERHANG is reduced and rigidity considerably increased in this new live center which incorporates a New Departure preloaded bearing. The device slips over the end of a lathe quill and is anchored in position by a split wedging ring. A tapped hole is provided in the center into which a driving rod can be screwed in case the point needs regrinding. Access to this hole is gained by removing a pipe plug in the backing plate. Grease is used for bearing lubrication, and instances can be cited where the New Departure Double Row has performed steadily for three years in live centers without perceptible wear. A simple two-piece closure in front keeps out dirt and drains off any slight amount of cutting compound which might pass the first wall. This device is a splendid example of the space-saving characteristics of the New Departure Double Row bearing. Because of its rigidity, high thrust capacity and accuracy, it is being widely used in many fine machine tools. Our engineers will be glad to recommend suitable mountings for it in your machines. » » » The New Departure Manufacturing Company, Bristol, Conn. Branches at Chicago, Detroit, San Francisco, and London, England.

NEW DEPARTURE
BALL BEARINGS

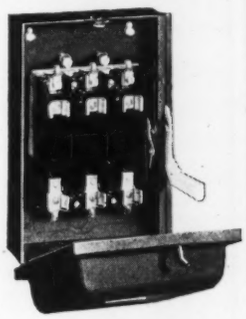
pulleys and at the same time automatically maintains the belt at proper tension.

Slow speed gears can be built integral with the output shaft, thereby providing single or double reductions giving extremely low speeds, down to five revolutions per minute, or increasers giving speeds up to 15,000. The vari-speed motors are furnished in both open and enclosed types and in a variety of ratings, ratios and combinations.

Switches Have Greater Capacity

WHILE the cabinets of the new switches brought out by Switch & Panel division, Square D Co., Detroit, have much smaller external dimensions than previous designs, capacity has not been reduced as the arrangement of the base permits the entire area of the back of the box to be used for wiring. This is accomplished by the elevation of the base from the back of the box by means of four mounting posts allowing ample room for wiring.

Compactness of the line may be illustrated by the dimensions of the new 3-pole, 60-ampere, 575-volt model which is only 13½ inches high, 8 inches wide and 5½ inches deep as compared with the previous model which was 17 inches high, 14¾ wide and 6½ deep. No bolted sections are required in the construction of the operating handle as it is mounted to the side of the box independent of the balance of the operating mechanism. The switches have a complete interlock, quick make and break and a double break method similar to that used on panels manufactured by the company.

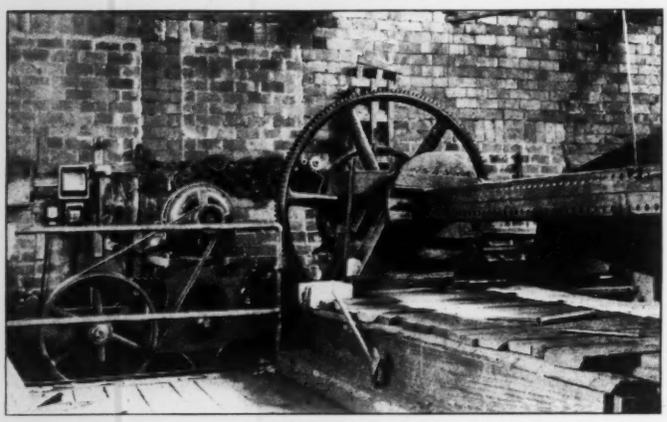


Arrangement of the base in new switch permits the entire area of the back of the box to be used for wiring

Lubricant Has High Film Strength

TO THE group of lubricants which the designer may specify for use in his machine has been added a new industrial lubricant which has unusually high film strength due to a special polymerization treatment developed by E. F.

THE LEWELLEN TRANSMISSION IN THE VENEER INDUSTRY



The Lewellen Automatic Veneer Lathe Control operates to maintain a uniform cutting speed at the surface of the log. It also results in a more uniform thickness of veneer, with less loss of time or spoilage of material.

A veneer manufacturer in Indiana installed a Lewellen Variable Speed Transmission with electrical control, on his rotary lathe. He reports an increase of 40% in his production together with a marked improvement in the quality of his veneer. The Lewellen has paid for itself long ago, and will continue to return a profit for many years in improved quantity and quality of output.

It is simple in principle, easily applied to any rotary lathe, and automatically adjusts the speed of the log, to its decreasing diameter at all times.

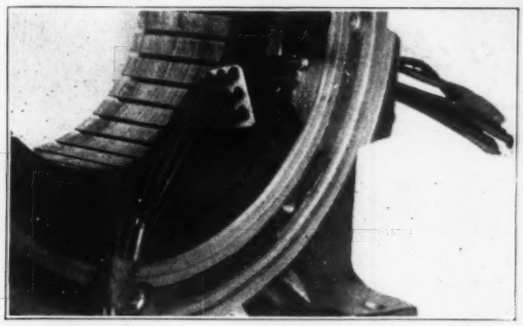
You too will find that it costs less to have the Lewellen Transmission, than to try to do without it. It is indispensable in any operation when accurate variable speed control is a factor in production cost, or in the quality of your product.

Let us give you a layout and recommendation for your lathe, with prices, etc. This will not cost you anything and will place you under no obligation.

THE *Lewellen* MANUFACTURING CO.
COLUMBUS, INDIANA

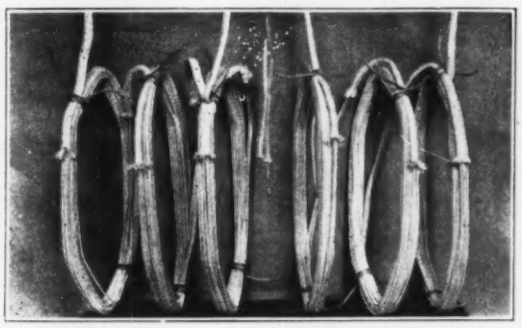
"It costs no more to have the best"

A bad habit that may lose a sale



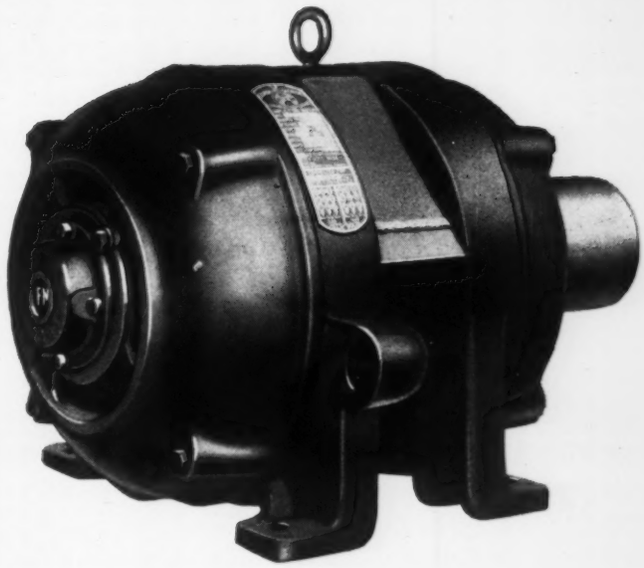
1. Sealed-in leads. Through an opening in the frame—and there anchored permanently with a special sealing compound. The roughest kind of handling during installation or afterward cannot put strain on the stator winding connections.

2. Special cuff insulation. Empire cloth inside of two special preformed fibrous sheets is inserted in the stator core slots. An ingenious method of folding makes a self-locking cuff and gives permanent protection from slippage and added protection to the windings.



3. Group wound coils. A phase group winding from one piece of wire—reduces end connections and eliminates a source of mechanical failure. Lead connections from these phase windings are welded, not soldered or brazed. An innovation in winding construction that keeps motors out of the repair shop.

4. Every motor is given a thorough vibrometer test to make sure of proper running balance. Eliminate vibration and you reduce to a minimum the wear on bearings. Sealed - ball bearings and smooth running insure trouble - free service from F-M Motors under severest operating conditions.



Surface judgments and surface habits won't do in this market. The habit of buying by the standards of four years ago may lose a sale for you.

Buyers have learned that today's competition has created new values and new qualities which were non-existent in the days when buying was done solely on the basis of the nameplate.

When you use today's Fairbanks-Morse Motors as standard equipment on your product, you are given additional sales features above and beyond the trademark. Your salesmen can point to tangible and important motor improvements which make your machine the better buy. F-M Motors assist you to meet successfully the keen discrimination of today's buyers.

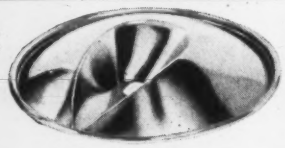
Just a few of these features are shown in the column at the left. The *complete* description of this extra value will be sent on request. Address Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago. 32 branches at your service throughout the United States.

FAIRBANKS-MORSE
MOTORS

POWER PUMPING AND WEIGHING EQUIPMENT

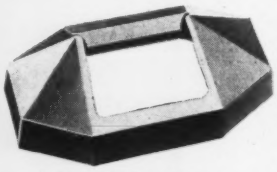
5853-AEF40.5

Sheet metal cover, stamped and drawn in one piece.



Let the G. P. & F. 19-Acre Stamping Plant Be Your Branch Factory

More than half a century under the same management — a 19-acre plant — stamping engineers to help you get your products ready for production — unequaled facilities for producing stampings of all sizes, all materials — these are available to you if you consult G. P. & F.



A seamless steel ticker case top produced by G. P. & F.

G. P. & F. Stampings are accurate, they eliminate waste, add to strength and beauty. Let G. P. & F. be your branch without branch factory worries. Send blueprints or sample—let us make recommendations. Ask for Booklet, "*In Harmony with Modern Progress.*"

GEUDER, PAESCHKE & FREY CO.

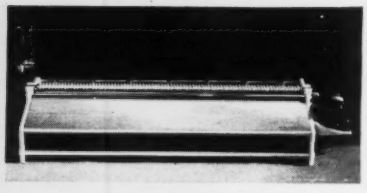
Sales Representatives in Principal Cities in All Parts of the Country

1417 W. St. Paul Ave., Milwaukee, Wis.
364 W. Ohio St., Chicago, Ill.

G.P.&F. STAMPINGS

NRA WE DO OUR PART

Announcing



the NEW No. 2836 Motor-Driven BW Developing Machine. Develops BLACK AND WHITE positive prints directly — without use of negative — on paper exposed in your blue printing machine. This machine has Bruning quality throughout—yet it sells at the amazingly low price of $57.50 (slightly higher west of Rockies). Wired for 110 A. C. Write today for complete information.

Charles Bruning Company, Inc.
Since 1894

Home Office
102 Reade Street
New York City

Chicago Office
445 Plymouth Court
Chicago

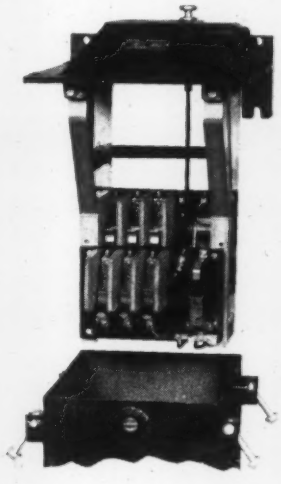
Boston Detroit Pittsburgh Los Angeles St. Louis Newark

BRUNING

Houghton & Co., Philadelphia. These new products are made of a pure mineral oil which is polymerized under controlled heat and pressure. This treatment results in a complete rearrangement of the molecules of the oil without any change in its chemical content, thus producing a closer bond between the molecules and a consequent increase in film strength. The lubricants are made in three series and are available in grades for nearly every type of industrial equipment.

Explosion Proof Starters Announced

NEW oil immersed combination switches, designated as type Cr7008 and available in three sizes for motors up to 50 horsepower at 440 volts have been announced by General Electric Co., Schenectady, N. Y. The switch, shown herewith, is suitable for use in paint factories, lac-



Oil immersed combination switch is suitable for use in locations where explosions might occur accidentally

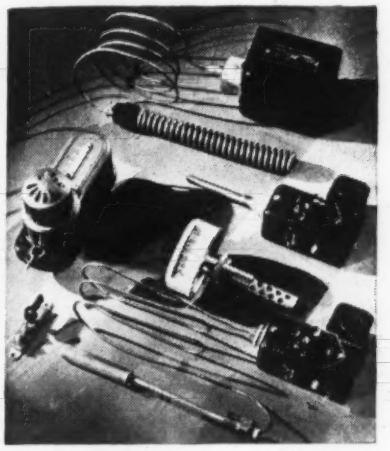
quer plants, oil refineries, chemical houses and in other places where it might be exposed to corrosive and explosive gases.

The control consists essentially of three parts: A magnetic switch, a motor circuit switch and a thermal overload relay which is reset by a plunger extending through the top cover. These parts, together with all connections, are located six inches below the surface of the oil in a tank of welded construction.

Units Control Electric Heating

TEMPERATURE controls for use in connection with various heating applications have been announced by Edwin L. Wiegand Co., 7575 Thomas boulevard, Pittsburgh. The line, shown herewith, comprises devices for indicating and

controlling temperatures in tanks, machines, hydraulic press platens, ovens and furnaces, melting pots and other equipment. Thermostats for



Line of controls is designed for use with the many forms of electrical heating applications

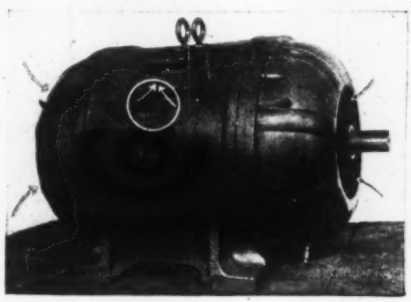
controlling the temperature of electric units used for heating rooms, isolated shops and offices also are included.

Small Photocell Is Introduced

PARTICULARLY of value as a test and experimental unit, the electric eye being manufactured by J. Thos. Rhamstine, 516 East Woodbridge, Detroit, employs a dry-disk type photocell, a small battery and a sensitive relay with accessible adjustment. This device provides the basic unit for simple set-ups to control lights, bells, doors, fire, smoke and burglar alarms, and to count articles on conveyors, provide remote measurements of liquids and to test the density of liquids. With the use of an auxiliary relay this device can be adapted to the operation of bigger jobs.

Two Air Ducts Cool New Motors

TOTALLY enclosed motors up to 200 horsepower with mounting dimensions comparable to open types have been brought out by Westing-



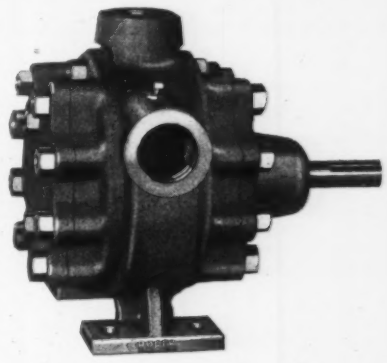
Frame of totally enclosed motors contains two sets of ducts through which the cooling air circulates

house Electric & Mfg. Co., East Pittsburgh, Pa. Internal and external air is circulated by fans through paths which cause rapid transfer of heat

ROPER

TRADE MARK

Pumps For All Commercial and Industrial Duties



Hydraulic Pumps:

A complete line of Hydraulic Pressure Pumps for actuating machine tools, road machinery, elevators, lifts, stokers, etc. Wide variety of sizes, capacities, and mounting designs. Types for either lubricating or non-lubricating liquids. Pressures up to 1,000 lbs.

General Industrial Pumps:

Large and small capacity pumps for thick liquids or thin—acids or alkalies—corrosive or combustible. Pumps for machine tools; for soap, glue, rubber, dye and chemical works; for textile plants; for molasses, liquid foods, asphaltum, grease, brine, gasoline, lacquer, beer. Skilled engineering and production forces to produce what you want.

Coolant Pumps:

One way and reversible types with wide range of capacities and flexibility of mounting design,—for all types of machine tools. With or without built-in relief valves. Only two moving parts. Positive delivery; smooth, forceful, non-pulsating flow.

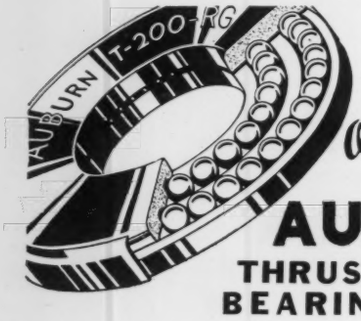
Hand Transfer Pumps:

Portable or permanent attachment to any type of container. For light or heavy liquids. Also non-ferrous, non-sparking, non-corrosive hand pumps which are fire proof, vapor-proof, explosion-proof and underwriters' approved.

Geo. D. ROPER Corp. — Rockford, Ill.

(Builders of Pumps Since 1857)

PUMPS



Answers that limited space problem

AUBURN THRUST BEARING T-200

When thickness space is limited and large diameter rotating parts having short journal bearing support must be steadied, Auburn Multiple Groove Thrust Bearings solve the problem.

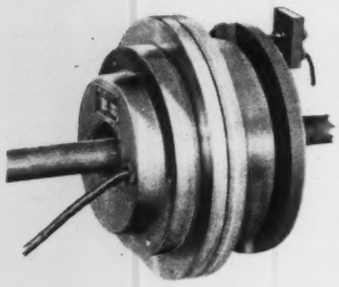
Send details of your difficulties and ask for Auburn Ball Bearing Data Book.

STEEL, BRONZE, MONEL, ALUMINUM BALLS

AUBURN BALL BEARING CO.
59 Clarissa St., Rochester, N. Y.

Founded 1893

NEW STEARNS COMBINATION MAGNETIC CLUTCH AND BRAKE



PROVIDES both clutch and brake action for motor driven spindles on machine tools. Belt shifting and manual stopping are wholly eliminated; accurate control of the machine is easily maintained when equipped with this unit. Smooth, positive clutch or brake action is provided by magnetic operation.

Details: Magnetic clutch is 10 inches in diameter; torque rating of 1000 inch lbs. Magnetic brake is 8 inches in diameter; torque rating of 350 lb. inches. Armature is slideably keyed to the shaft and used for both clutching and braking. Collector rings are mounted within sheave to conserve space; a unique feature.

Compact, simple, and sturdy. Write for complete information.

MAGNETIC MFG. COMPANY
651 TL—S. 28th St., Milwaukee, Wis.

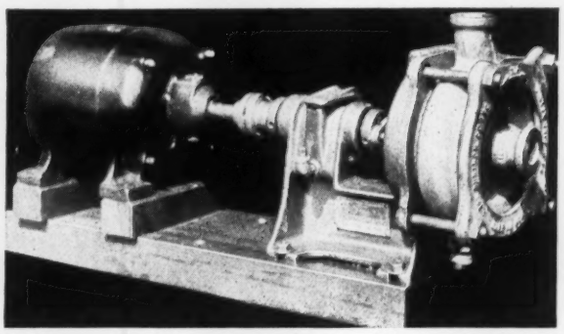
HIGH STEARNS DUTY

from the internal air to the frame and from the frame to the external air.

The frame contains two sets of ducts. The first set runs from one end to the other, inside the motor. Internal ventilating air is drawn by the internal fan through the air gap and rotor core vent holes and is driven through the stator and turns, and through the internal ducts under the stator core. The second set of ducts alternate with the first and pass from each end to the center of the motor. Double end ventilation is used on the larger machines. Since the ducts carry external air in close proximity to the internal air there is a heat exchanger effect.

Pumps Will Handle Corrosive Liquids

CENTRIFUGAL pumps for handling corrosive chemicals in extremely small sizes are now being built by Duriron Co. Inc., Dayton, O. The pump, shown herewith, has a 1-inch suction, 1-inch discharge, and at 1750 revolutions per minute the head and capacity range from 2½ gallons per minute at a 25-foot head to 25 gallons per minute at a 5-foot head with power consumption varying from approximately ¼ to less than ½ horsepower. These figures are based on water. The unit is available in either belt or direct motor drive and has a closed type impeller. Pumps are procurable in a variety of materials best suited for resistance to the various conditions which might be encountered in pumping chemicals.

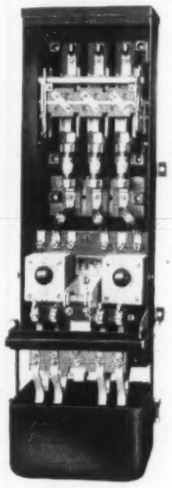


Centrifugal pump units are available with either belt or direct motor drive

Magnetic Starter Is Compact

FOR motors up to 15 horsepower, 220 volts and 30 horsepower, 440-550 volts, Electric Controller & Mfg. Co., 2700 East seventy-ninth street, Cleveland, has announced the type ZOS oil immersed across-the-line combination magnetic starter. This starter, shown herewith, contains an unfused or fusible safety switch, a magnetic starter with overload relays, and heavy duty test jacks for those applications where it is

desired to insert meters in the motor circuit without interrupting the operation of the machine. All of the internal wiring of these starters is



Across-the-line combination magnetic starter contains an unfused or fusible safety switch, a magnetic starter with overload relays and heavy duty test jacks

complete. The starters are unusually small and narrow, having safety switch front operation and a cover that swings vertically.

Nickel-Clad Steel Sheets Available

NICKEL-CLAD steel sheets in thin gages, hot rolled and cold rolled with bright and polished finish are being manufactured by H. Boker & Co. Inc., 103 Duane street, New York. These sheets are made by hot welding a slab of pure nickel on to a steel base at a high temperature, approaching fusion, at high pressures. The company furnishes hot rolled, annealed and pickled sheets from No. 16 U.S.S. gage up to and including heavy plate sizes, and cold rolled sheets and strips with polished surface as thin as No. 32 U.S.S. gage.

Power Panels Are Convertible

FOR power and feeder installations where circuits do not exceed 100 amperes, 250 volts, the Switch & Panel division, Square D Co., Detroit, has brought out Saflex Jr., a line of safety convertible power panels. These panels, obtainable for either flush or surface mounting, are mounted in cabinets only 6 inches deep and 19 inches wide. Circuits of 30 and 60 amperes are available in either twin or single units, while 100-ampere circuits are manufactured in single units only.

I SEE in this new scheme of things a challenge to our inventive genius, a greater opportunity than ever before for the development of new products, to be manufactured by new low cost processes, to be bought by the great new masses of purchasing power."—Malcolm Muir, deputy administrator of the NRA.

"Spot" says:

"Let me spot your heat exactly where you want it"

TWO spots of heat were needed to seal the packages in this ice-wrapping machine, which operates in a room at freezing temperature. Two "Spots"—G-E cartridge-type electric heating units—solved the problem simply and easily. They thoroughly heated and dried the glue used to hold the wrapper in place, even though the heaters were pressed against the wrapper, which was directly in contact with the ice.

You may not operate an ice-wrapping machine, but you may have a process machine, or a dozen "fussy" heating problems that "Spot" can easily solve. Spot heaters cost so little that you can use them everywhere. They are priced as low as $2.00. Order them from your G-E mail-order catalog, which describes and prices the complete line of G-E Midget heating units and devices.

If you haven't a copy of our mail-order catalog, fill in this coupon and mail it to the nearest office of your power company, or write General Electric, Schenectady, N. Y.

571-10

GENERAL ELECTRIC

Please mail me a free copy of the General Electric mail-order catalog, GEA-1520, on small electric heating units.

Name.....

Firm.....

Street.....

City..... State..... (MD)

Apologies to

MR. RIPLEY

"Believe It Or Not"

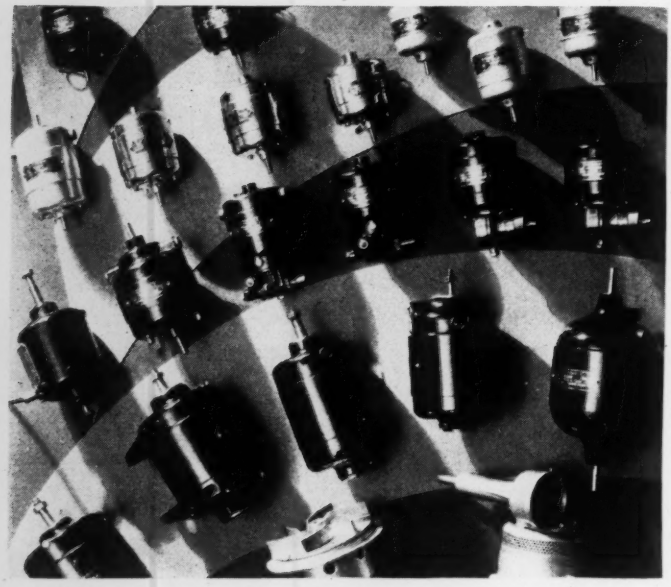
THE *Original* VIKING

ROTARY PUMP IS STILL IN OPERATING CONDITION

In spite of the fact that the original Viking is 29 years old it is still in condition to do a hard day's work.

As further proof of the old Viking's sturdiness is the fact that he is the proud grandfather of nearly 400,000 Viking Pumps . . . scattered to the four corners of the globe . . . performing every conceivable kind of work. For economical first cost . . . for low power requirements . . . for long life . . . investigate the Viking Rotary Pump. Write today for FREE Folder.

VIKING PUMP COMPANY
Cedar Falls, Iowa



DUMORE
FRACTIONAL HORSEPOWER
MOTORS

Applicable to a Wide Range of Design

Small tool, electrical appliances, precision and scientific instruments. . . all these, and many other design problems lend themselves to the use of a Dumore Motor. And the more important the factor of performance the more you will appreciate the adaptability and fine performance of these superior motors. Technical bulletins describing them may be had upon request.

DUMORE COMPANY 100 Sixteenth St. Racine, Wisconsin

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MACHINE DESIGN
is a monthly technical publication conceived, edited and directed expressly for those executives and engineers responsible for the creation and improvement of machines built for sale, and for the selection of the materials and parts to be used.

DRIVES—Diamond Chain & Mfg. Co., Indianapolis, is distributing an attractive 96-page catalog, No. 583, which contains complete information on where to use roller chain, how to select proper sizes and sprockets, calculation formulas and tables for determining chain length, tables giving complete data on chains of varying pitches, single and multiple strand, and sprocket data for all pitches of chain. The catalog also includes information on special types of chain and on chains of special materials.

DRIVES—Planigressive speed reducers and speed increasers are covered by three catalog inserts issued by Davis & Thompson Co., Milwaukee. The reducers are a motor and gear set combined into a single drive unit.

DRIVES—Speed reducers of single, double and quadruple reduction ratios, variable speed reducers and other equipment are covered in catalog No. 6 of Cullman Wheel Co., Chicago. The speed reducing units are arranged so that any standard make of motor can be mounted as an integral part of the equipment.

ELECTRONIC EQUIPMENT—Photoelectric relays, the principles of their operation, typical applications and descriptions of types are included in a well prepared booklet, GEA-1654A, of General Electric Co., Schenectady, N. Y.

FASTENINGS—Kellogg Switchboard & Supply Co., Chicago, is distributing a folder on its Tapster, an all purpose, self-tapping machine screw available in all standard sizes for fastening metal, bakelite, slate, fiber, etc.

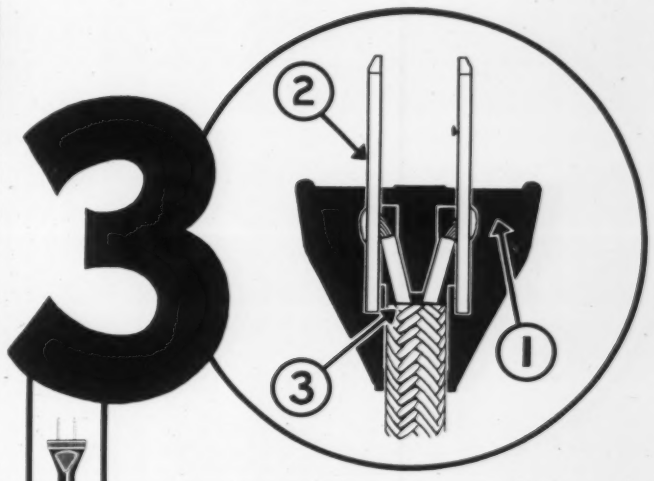
LUBRICATION AND LUBRICATING EQUIPMENT—Gits Bros. Mfg. Co., Chicago, is distributing a booklet on its new line of constant level bottle oilers for motors, lineshafts and oil reservoirs. These oilers have a glass reservoir which permits the oil level to be seen at any time. A hinge type oiler in the line can be filled without removing the bottle.

MAGNETIC EQUIPMENT—Magnetic Mfg. Co., Milwaukee, has prepared bulletin No. 100 on magnetic separation as applied to a number of industries.

MOTORS—Recently introduced capacitor start, induction-run motors which have no sliding electrical contacts are described in a bulletin of Emerson Electric Mfg. Co., St. Louis.

PUMPS—Chain Belt Co., Milwaukee, has prepared a 16-page catalog, bulletin No. 240, covering its line of Rex speed prime pumps. Sample problems, illustrations and design data are included to cover the problem of the application of these pumps completely.

WELDED PARTS AND EQUIPMENT—Step-by-step procedures for oxyacetylene welding of steel, cast iron, copper, brass and lead piping and for making fittings on the job are included in a 160-page book entitled "Fabrication of Oxwelded Piping," issued by Linde Air Products Co., New York. Seventy-five illustrations and twenty ready-reference tables are included.



Outstanding Features of the Belden Soft Rubber Plug

The Belden Soft Rubber Plug is fully covered by patents in the United States and many foreign countries. Its construction is unique. It is, today, the accepted standard of the electrical industry in attachment plug design and performance, because:

1 Belden cap is molded of rubber throughout—no breakable parts.

2 Belden blades are set in slots molded in rubber cap. They cannot break loose nor be forced permanently out of position. Blades are self-aligning and always retain a firm grip in any outlet.

3 Conductors are soldered to blades; no screws—no loose strands. (See diagram above.)

The Belden Soft Rubber Plug outlives the appliance.

Belden Soft Rubber Plugs are now available on safe cords through the Belden Manufacturing Company or any of the following Belden licensees:

In U. S. A.

American Steel & Wire Company
Anaconda Wire & Cable Company
Diamond Braiding Mills, Inc.
Essex Wire Corporation
General Cable Corporation
National Electric Products Corporation
Packard Electric Corporation
John A. Roebling Sons' Company
Rockbestos Products Corporation
U. S. Rubber Company

In Canada

Viceroy Mfg. Co., Ltd.—Toronto

Belden Manufacturing Company
4639 W. Van Buren St. :: Chicago

Belden